Public Health

Public Health

The Development of a Discipline

VOLUME I

From the Age of Hippocrates
to the Progressive Era

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FOREWORD

Any field of endeavor is characterized best by its contents and accomplishments—and not just those that are current. Concern for the health of populations, that is, public health, has a long history, and its documentation from ancient to modern times has been extensive. But what relevance do these historical documents have to modern concerns and practices? Some might dismiss the study of history and its documentation, arguing that old paradigms do not apply to modern situations. Others are likely to assert that without a knowledge of the history of a field it cannot be fully understood. But history is more than the chronicling of the application of "successful" paradigms. History provides the context in which human accomplishments are realized. It defines a field, describes its content during various eras, and gives meaning to the endeavor.

When nineteenth-century anesthesiologist John Snow turned his attention from the study of the actions and uses of anesthetic gases to the cause of epidemic cholera, we are introduced to an example of inductive reasoning resulting in a classical field investigation that led him to conclude that the causal agent of the deadly disease was transmitted in the public drinking water supply. Snow reached this conclusion a quarter century before the science of bacteriology permitted a more direct demonstration of the nature and action of that agent. His investigations provided a strategy for the control and prevention of a whole class of deadly infectious diseases. Public health practitioners cannot avoid being stimulated by a study of Snow's investigation. Snow's research, however, was only possible because of the imperatives resulting from the environmental degradation created by the industrialization of Victorian England.

A study of historic documents also provides a definition of the field. Nowhere is this more apparent than in the writings of Hippocrates, the medical genius of the "Golden Age" of Greece. His essay *On Airs, Waters, and Places* is a prime example defining a field. Hippocrates introduced his discussion with the words "Whoever wishes to investigate medicine properly should proceed thus"; and he then listed such phenomena as climate, water quality, elevation, occupation, diet, lifestyle, and in his translated words, "everything else." His compendium is still a comprehensive description of the content of the fields of environmental, occupational, and behavioral health.

Historical documents also describe a field during various eras of its changing content. An understanding of the dynamics of such change is fundamental to an appreciation of the field as a profession. A good example of such a document is Sir George Baker's 1767 publication *An Essay Concerning the Cause of the Endemial Colic of Devonshire*. In this publication, Baker used descriptive observations to correctly infer that the disease resulting from drinking "Devonshire" cider was due to its adulteration with lead used in caulking the local apple presses. Baker was the first to use a laboratory in an epidemiological study. He also describes the phenomenon of exposure without subsequent pathogenicity (penetrance), the key to an understanding of the etiology of many diseases. Finally, Baker proposed specific remedial legislative action to prevent the continued occurrence of the disease.

In *Public Health: The Development of a Discipline. From the Age of Hippocrates to the Progressive Era*, the reader will find annotated historical documents providing context, definition, content, and meaning to the field of public health. And most important, the reader will be inspired and proud as the classics of the field reveal the commitment of its movers and shakers to the health and well-being of humankind.

Warren Winkelstein Jr.
Berkeley, California
April 23, 2007

PREFACE

The complete or partial works included in this volume were scanned, transcribed, or typed from the originals, from copies of the originals, or from translations. In our search for classics in public health, we found that some works were reprinted several times, had updated versions of the originals or new editions with introductions or commentary, and appeared in different formats in a variety of places. We also found that some works were translated by different individuals, leading to discrepancies in the editions. In those instances, we reconciled the differences to the best of our ability rather than selecting one translation over another. In all cases, we note the sources we used at the end of each work so that the reader may check the accuracy of our efforts.

Historical works are often hard to read because of typeset style and archaic word usage. Specifically, the typeset style used for some of the original works, such as using *f* for *s* or putting spaces before punctuation, creates a distraction for the reader. We standardized the presentation of the works using one typeset style and a modernized punctuation format. We often chose to keep the Old English spelling and grammar from the original works. For example, the reader may find *hygeine* rather than *hygiene*, *onely* rather than *only*, or *then* instead of *than*. Where the spelling or word usage is nonstandard even for Old English, we have placed "[*sic*]" at the end of the sentence or paragraph to let the reader know they have not stumbled upon an error.

The endnotes to this volume are extensive. First, they include the footnotes from the originals or the translations in order to maintain the flavor of the work. Second, as early formal writing often included many Latin, French, and German phrases, the endnotes include most of these translations. Third, where Old English or archaic word usage might hinder the understanding of a passage, an endnote is included to aid the reader in its meaning. Finally, we occasionally added our own comments for perspective, identified as "[Ed.]."

We hope our efforts will present the reader with an enjoyable experience with the classics of public health literature.

ACKNOWLEDGMENTS

The authors would like to thank Professors Manning Feinleib, Michael R. Greenberg, Gerald F. Pyle, and Warren Winkelstein Jr. for encouraging us to publish this set of historic pieces that guided the development of public health, especially in the English-speaking world. We also thank the Rutgers University Press for encouraging us to be thorough in our efforts, even at the expense of two volumes. Finally, we thank our many undergraduate and graduate students who, over the years, have been especially enthusiastic about discussing these seminal works with us. It is from many of those conversations that we found true inspiration.

INTRODUCTION

Those who do not study history are doomed to repeat it.

—George Santayana, *The Life of Reason*, 1905

History will die if not irritated. The only service I can do to my profession is to serve as a flea.

—Henry Adams (1838–1918), U.S. historian, journalist, and novelist

Life expectancy, or the mean age of survival of population groups, has risen over the millennia. For early humans, a nomadic lifestyle, small populations, and the absence of domestic animals originally limited the spread of disease. These early hunters and gatherers suffered from high mortality rates, mostly from trauma, infected wounds, or zoonoses, diseases acquired from eating infected animals or their excreta. Archaeological evidence tells us that the life expectancies of these early populations were short, with the average person living perhaps 20 years.

Around 12,000 years ago, large wild mammals became extinct, and the nomadic lifestyle became less practical. By necessity, food sources shifted from hunting and gathering to small-scale agriculture. Early domesticated plants were poor in nutritional value, and human mortality remained high. It was not until around 8,000 years ago that improvements in agriculture allowed for food production large enough to support increases in both average family and overall population sizes. Villages and towns emerged as places for the exchange of surplus food and goods. Density increased, with people and animals living side by side, often sharing the same living quarters. Humans became widely infected with parasites, food-borne and waterborne diseases, and respiratory diseases. Life expectancy remained, on average, short.

By the time of Hippocrates (c. 400 BCE), the average life span had risen to about 28 years, with significant variation based on class, gender, and geographic region. Improvements included access to water in sufficient quantities for personal hygiene and of adequate quality to reduce waterborne diseases. Well-established overland trade routes reached across the Middle East and into Asia. Cargo ships routinely sailed across the Mediterranean. As travelers returned home, they brought stories about new lands and peoples with them, including tales of strange lifestyles and diseases. As scrolls were fragile and books nonexistent during this period, oral tradition was important for teaching. Those stories that could be confirmed by more than one traveler, or perhaps brought back by a reputable physician, were more than likely accepted as authoritative. When the reader takes on the first reading in this volume, *On Airs, Waters, and Places*, the importance of oral tradition as the authority for early works becomes clear. *On Airs* makes statements that today we might challenge, but the original scrolls contain no information about the source of the claims so that we might judge their validity.

Over the centuries, oral tradition was replaced by the written word. Later, scribes were displaced by printing presses, and books became affordable after the creation of movable type by Johannes Guttenberg around the year 1450. Personal and scholastic libraries were created where authors could to do academic research. Travelers published their diaries, letters, and personal papers. Military and commercial records were bound as books for future reference. This availability of printed information had an impact on academic writing that was as important then as the Internet is for researchers today. For example, James Lind's complete work *A Treatise on the Scurvy* contains scores of pages (not included here) that describe the voyages of sea captains where many crew members suffered from scurvy. Lind is careful to cite the captain or admiral whose logs or other reports he researched, attributing statements about scurvy and varying claims for its treatments to their source. George Baker and Edward Jenner include footnotes in their pieces on the Devonshire colic and cowpox, respectively, to refer to other authorities who also wrote about these topics. Edwin Chadwick's complete work *A Supplementary Report on the Results of a Special Inquiry into the Practice of Interment in Towns* contains multiple in-text references to letters from physicians about the horrors of burial practices typical among the lower classes in nineteenth-century England. The practice of stating the findings of others, whether similar or dissimilar to the thesis being put forward, reflects the rise of the scientific method and the ready availability of reference materials.

The impact of the second Agricultural Revolution and the Industrial Revolution should not be lost on readers as they proceed through these historical works. The role of nutrition and economic growth play a large role in the improvement of the health of the public. For instance, until 1750, infant mortality was as high as 25 percent in Europe and the diet of the average European meager, limited in nutrients, and high in toxic substances such as lead, salt, and alcohol. The situation was not much better in America. According to Robert W. Fogel (1994), the average height of adult males in England at that time was four feet seven inches, exceeding that of France and Norway. S. H. Preston (1995) notes that in 1800 life expectancy in France was just under 30 years, and in Great Britain it was about 36 years. These are life expectancy levels that China and India did not reach for yet another 100 years. Indeed, the impact of the Agricultural, Industrial, and Sanitary revolutions in the West produced significant changes in human longevity. By 1850, U.S. whites had a life expectancy of almost 40 years compared to that of U.S. blacks, many of whom were enslaved, at 23 years. Nowhere in the world was discrepancy in life expectancy between the privileged and the oppressed better demonstrated.

The quantitative revolution also emerged as a cornerstone of science between the seventeenth and twentieth centuries, and it is well reflected in the writings contained in this volume. In 1650, for example, John Graunt tabulated and drew conclusions about the Bills of Mortality in London. He made no claims about disease etiology, however, and put forth no suggestions for improving mortal outcomes. By the mid-1800s, William Farr argued for the creation of databases (vital statistics) that not only would allow others to study outcomes but would help sanitarians and medical researchers infer the etiology of diseases. William Shattuck went farther still, using data to deduce the causes of ill health and outlining both the monetary and human costs of providing (or not providing) public health interventions.

The sanitary reformers applied careful reasoning and logic to the problems of health and illness, and their arguments for clean air, clean water, sewers, and trash removal led to an increase in the average life expectancy of Americans to almost 48 years by 1900. Reforms in Europe raised life expectancy to 50 years in Britain and 44 years in Italy. The sanitary reformers claimed their authority from data, not the writings or opinions of others. Indeed, their passion was one we wish we saw for public health today. This volume is meant to honor the work of all the writers presented in this volume, and we hope our passion for the history of public health as it developed into a modern discipline comes through to the reader.

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CHRONOLOGY

Part I Early Roots

c. 500 BCE The Cloaca Maxima (big sewer) is built in Rome. As the city grows, a network of cloacae (sewers), aqueducts, and baths are built to accommodate the public need.

787 The archbishop of Milan attaches a cradle to a revolving exterior church door, providing the first organized system for receiving abandoned infants. Missionaries continue the practice in Jerusalem (1210), Arabia (1283), Mexico City (1524), Lima (1563), Bogotá (1650), Pernambuco (1650), and Beijing (1662).

c. 890 Cairo receives a new water supply from an arched viaduct in the southern desert.

c. 1300 Londoners begin using coal for heating, and the city's air becomes visibly smoky.

1348 The Black Death (bubonic plague) appears in Istanbul (Turkey), most likely via trade routes from Asia. It reaches England by May of this year.

1366 The city of Paris forces butchers to dispose of animal wastes outside the city.

1377 Venice declares a moratorium on trade and attempts to ward off the Black Death by enacting a 30-day waiting period (*trentino*) to enter the city. Dubrovnik enacts a 40-day waiting period (quarantine).

1388 Parliament passes an act forbidding throwing filth and garbage into ditches, rivers, and waters. The city of Cambridge passes the first urban sanitary laws in England.

1495 Syphilis first appears in Europe.

1523 The Hôtel Dieu, the oldest hospital in France, begins accepting abandoned children so that they would not be purposefully maimed and sold as beggars.

1546 Italian physician Girolamo Fracastoro outlines a theory of contagious disease, claiming that isolation and disinfection are effective against epidemics.

1589 The water closet is invented by Sir John Harrington in England, but the invention is ignored until 1778, when Joseph Bramah begins marketing a patented water closet.

1601 Parliament passes An Acte for the Reliefe of the Poore. This Elizabethan Poor Law consolidates policy toward the poor by determining that; (1) the parish is the administrative unit responsible for the poor; (2) the able-bodied poor should work or, if they refused, be sent to prison; (3) those unable to work for mental or physical health reasons should be sent to almshouses; and (4) able-bodied children should be set to work or apprenticed.

1636 A foundling hospital, La Couche, opens its doors in Paris in 1636. Vincent de Paul takes over the facility in 1640, renaming it the Hôpital des Enfans-Trouvés. The facility installs a Tour d'Abandon (Desertion Tower) in a revolving door to receive abandoned infants.

1659 Smallpox kills 1,500 people in London.

1660 The first orphan house in North America opens in New Amsterdam (New York).

1661 John Evelyn writes *Fumifugium, or The inconveniecie of the aer and smoak of London dissipated*, proposing large public parks and flowers as remedies for London's air pollution problem.

1690 Paris becomes the first European city with an extensive sewer system. See Frederique Krupa's *Paris: Urban Sanitation Before the 20th Century*.

1712 Bernardo Ramazzini publishes *De Morbis Artificum Diatriba*, describing the hazards of 52 occupations. He suggests that better diet and less arduous work will allow people better health.

1721 Lady Mary Wortley Montagu popularizes smallpox inoculation, a practice she observed in Turkey.

1732 The Philadelphia Almshouse opens with separate foundling facility.

1741 The Foundling Hospital of London is established. Children's hospitals are also built in Germany and France.

1750 A typhus epidemic sweeps through London.

1751 Pennsylvania Hospital, the first hospital in the colonies, is established in Philadelphia.

1762 Devonshire colic appears in Exeter hospitals.

1769 George Armstrong establishes the Dispensary for the Infant Poor in London, the first organized outpatient medical care for children.

1788 A report of the Académie des Sciences recommends that Parisian hospitals separate patients with infectious diseases from those who are chronically ill. The system is instituted but subsequently ignored.

1796 The first organized medical care service in New England is founded at the Boston Dispensary in Massachusetts.

1798 The Marine Hospital Service Act (Chapter LXXVII, Sections 1–5) provides for the temporary relief and maintenance of sick and disabled seamen, the first prepaid medical care program in the United States. The Marine Hospital Service is the predecessor of the U.S. Public Health Service.

1799 U.S. states are granted federal help for enforcing quarantine law.

Part II The Sanitary Reform Movement

1793 The first local health department with a permanent board of health is formed in Baltimore, Maryland.

1838 The Poor Laws Commission in England finds that poverty is linked to disease, poor housing, and sanitation.

1842 English engineers lay out sewer system in Hamburg, Germany, and the English system of house-by-house sewer lines is adopted across Europe.

1842 New York physician John H. Griscom is appointed inspector for the Board of Health. While Griscom condemns landlords who turn basements into "living graves" for human occupants, he is ineffective at forcing change.

1843 Dorothea Dix spawns a prison reform movement in the United States.

1845 The Massachusetts Sanitary Commission determines that Boston slums have alarmingly high infant and maternal mortality rates as well as many communicable diseases.

1847 Cholera attacks London.

1847 The Towns Improvement Clauses Act encourages paving, drainage, cleansing, and lighting and gives large towns in England the power to appoint full-time medical officers.

1848 The American Medical Association is formed with two main initial goals: license physicians and survey sanitary conditions across the United States.

1848 A cholera epidemic kills 62,000 Britons.

1848 German physician Rudolf (Carl) Virchow founds the journal *Medicinische Reform*, focusing on what preserving health and preventing disease requires rather than palliation.

1848 Parliament passes the Public Health Act, creating a National Board of Health and encouraging local boards to regulate water supply, sewerage, and offensive trades. Smoke abatement becomes a political responsibility of the health department.

1849 Cholera strikes New York City, killing 5,000 mostly poor and Irish.

1850 The London Epidemiological Society is formed.

1851 The first formal international health conference is held in Paris, focusing primarily on drafting international quarantine regulations.

1854 John Snow convinces London authorities to let him close down the water pump on Broad Street.

1854 Britain's Board of Health is dismissed, partly because of Edwin Chadwick's uncompromising personality and partly because of a cholera outbreak. The *Times of London* says people "prefer to take our chance of cholera . . . than be bullied into health."

1854 New York Common Council rules that homes have to be connected to sewer lines. By 1857, two-thirds of New Yorkers still have backyard and basement privies that overflow.

1855 Chicago becomes the first city with a comprehensive sewer plan. By 1905, all U.S. towns with populations over 4,000 have city sewers. The Baltimore city sewer system, begun in 1915, is the last to be built.

1858 The "Great Stink" of sewage in the Thames River spurs Parliament to create the British Royal Commission on Sewage Disposal.

1858 The *Illustrated Weekly* takes on the "swill milk" industry in New York. Swill, the watery grain left over after brewing and distilling alcohol, was the only source of food for dairy cattle, leading to diseased cows and milk handlers as well as poor-quality milk.

1861 Adolf Kussmaul, professor of medicine in Erlangen, exposes the severity of mercury poisoning among factory workers in Fürth and

Nuremberg. His work leads Germany to switch to alternative mirror-making processes.

1861 Children's Employment Commission (UK) begins investigation into nontextile industries employing children, partly at behest of mill owners. A variety of reports on occupational disease are issued, including those found in the lucifer match industry, paper staining, percussion caps, cutlery grinding, and potteries. Ulceration of the jaw from matches, called "phossy jaw," was eliminated through international cooperation.

1863 Abraham Lincoln approves the congressional charter for the National Academy of Sciences.

1863 In New York, the Association for the Improvement of the Condition of the Poor reports that 18,000 people live in cellar apartments whose floors are putrid mud.

1865 The New York City Sanitary Survey reports a death rate of 33 per 1,000 (compared to Philadelphia at 20 and London at 22). Public health had deteriorated to conditions like those of London two centuries earlier.

1866 The New York state legislature creates the Metropolitan Board of Health with authority to conduct house-to-house inspections, remove nuisances, and order cleanups. Any person considered to be a threat was moved to a hospital. The police or the board's own officers would enforce the orders. As a result, a cholera epidemic that swept from Europe to North America killed only 500 in New York but 1,200 in Cincinatti and 3,500 in St. Louis.

1866 The American Society for the Prevention of Cruelty to Animals is founded. The organization later declares that children are human animals that need protection.

1867 Chicago opens new waterworks valves that take water from a point two miles out into Lake Michigan rather than from the polluted Chicago River.

1869 The first state Board of Health is established in Massachusetts.

1872 The American Public Health Association is formed.

1872 Investigation of drinking water by the *Newark Daily Advertiser* (New Jersey) finds sewage, animal carcasses, dead human bodies, and industrial poisons in the water supply.

1873 In December, the first of a series of killer fogs (1880, 1882, 1891, 1892) hits London, killing more than 1,150 people in three days.

1875 The British Publish Health Act sets the authority to deal with housing, water pollution, occupational disease, and other problems.

1877 In the United Kingdom, the Local Government Board finds one-quarter of all milk seriously adulterated.

1878 The National Quarantine Act empowers the surgeon general of the Marine Hospital Service to impose quarantines in the United States.

1878 In the United Kingdom, the Consolidating Act was passed, preventing children from working in white lead factories.

1880 A January "killer fog" in London kills 700 people.

c. 1880 The first U.S. municipal smoke abatement laws were devised so that local Boards of Health could enforce them as nuisance statutes.

1881 Chicago becomes the first American city to create a local ordinance regulating smoke discharge. Cincinnati, Pittsburgh, and St. Louis all had smoke ordinances by 1893.

1881 New York City creates a Department of Street Cleaning.

1882 Massachusetts passes first pure food laws.

1882 Robert Koch discovers the tubercle bacillus (1882) and the cholera bacillus (1883), proving the germ theory of disease.

1887 The Hygienic Lab (forerunner of the National Institutes of Health) is founded.

1906 Pure Food and Drug Act is passed.

1910 The Flexner report, *Medical Education in the United States and Canada* (Carnegie Foundation), is released.

Part III The Progressive Era

1885 Sand filtration is found to reduce bacteria in drinking water by 98 percent. By 1900, dozens of British and American cities had such filters. By 1905, copper sulfate, chlorine, and ozone treatments were found to kill typhoid and cholera bacteria.

1887 Rio de Janeiro hosts the first hemispheric health conference, which leads to the creation of the Pan American Sanitary Bureau (later the Pan American Health Organization, a regional arm of the World Health Organization [WHO]).

1893 In New York City, Lillian Wald and Mary Brewster found American Community Nursing. Wald establishes the Henry Street Settlement in New York and began using the term "public health nursing."

1907 A permanent international health organization is established in Paris to receive notification of serious communicable diseases and develop sanitary conventions and quarantine regulations regarding shipping and train travel. This organization is absorbed by WHO in 1948.

1908 The first continuous chlorination of water system in the United States begins operating in Jersey City, New Jersey.

1912 The Children's Bureau is established in the Department of Labor by an act of Congress to safeguard the health of mothers and children.

1921 The Sheppard-Towner Act is enacted, providing federal grants to states to promote maternal and infant welfare and hygiene for a number of years.

1920 Mary Breckenridge establishes the Frontier Nursing Services in Wendover, Kentucky, in response to her concern for high maternal and infant mortality rates.

1924–1928 Alice Hamilton takes an active role in exposing the ethyl leaded gasoline and radium industrial exposures in women.

Public Health

PART I

Early Roots

Drinking [moderately] is beneficial for body, mind and property. It is well suited to the deeds of Aphrodite and to sleep, a haven from toils, and to Hygeia, most pleasing of the gods to mortals.

—Greek Elegaic Euenus, Frag 6, c. 500 bce

I have long been satisfied from observation that besides the general colds now termed influenzas (which may possibly spread by contagion as well as by a particular quality of the air) people often catch cold from one another when shut up together in close rooms, coaches, &c., and when sitting near and conversing so as to breathe in each other's transpiration; the disorder being in a certain state.

—Benjamin Franklin, Letter to Benjamin Rush, 1773

Health is worth more than learning.

—Thomas Jefferson, Letter to John Garland, 1790

CHAPTER 1

HIPPOCRATES
(c. 460–377 BCE)

As to diseases make a habit of two things—to help, or at least, to do no harm.

—HIPPOCRATES, *Epidemics*, c. 400 BCE

HIPPOCRATES WAS BORN ON THE GREEK ISLAND OF COS (or Chios or Khios) in about 460 BCE (accounts vary). While he practiced medicine in Athens and other Greek cities, Hippocrates' fame comes from his founding of a medical school at Cos. There he produced (most likely with the help of his students and perhaps other physicians) the *Corpus Hippocraticum*, a series of about 70 treatises on the prevention, diagnosis, and treatment of disease. Indeed, as the works cover a time span of about 150 years, Hippocrates could not be the solo author. Some historians have hypothesized that the *Corpus Hippocraticum* was the entire library of the medical school at Cos. While we do not know if this is true, we do know that all of the pieces in the collection share one commonality—they are written in the Ionic dialect, which later became the language of Greek science.

Some of the works in the *Corpus Hippocraticum* have had a particularly lasting influence on both the practice of Western medicine and public health. *The Oath*, for example, addressed medical ethics, and the classic version was recited by new physicians at their medical school graduations until modern times. Today, most medical school graduating classes recite a modernized version that does not mention abortion or assisted suicide. Busts of Hippocrates remain in many Western medical school entrance lobbies today, entreating new physicians to remain true to their calling. Because of this continuing influence on the practice of medical ethics for physicians throughout the ages, Hippocrates earned the title "Father of Medicine."

Little is known about Hippocrates' private life. What is known is that he taught his students that detailed observation was important for diagnosing disease. He also believed that science could be used to link causes with particular disease outcomes. For example, Hippocrates taught that proper diet, fresh air, a moderate climate, and attention to habits and living conditions were necessary for healthy living. The treatise *On Airs, Waters, and Places* describes the effects of climate and environment on medical conditions and especially on the spread of epidemics. It is this work that has earned Hippocrates a second title—that of "Father of Epidemiology."

The date of Hippocrates' death is uncertain, but he apparently died at Thessaly at "an advanced aged." The date is given as circa 410 and circa 370 BCE in various sources.

A Note on the Text

On Airs, Waters, and Places has been translated many times into many languages over the millennia. The two most common English translations are by Francis Adams (1849) and W. H. S. Jones (1923). The Adams translation is widely available on the Internet, but what appears is sanitized, without footnotes. The Jones translation is particularly heavily footnoted, and the comments are helpful for understanding the complexities of the work. There are also English translations by Peter Low (London, 1597), John Moffat (London, 1788), and Francis Clifton (London, 1834).

When reading *On Airs, Waters, and Places*, the reader should note the ethnocentric rather than scientific nature of the work. The observations about differences among peoples and the linkages between where they live and their likely health outcomes are particularly noteworthy.

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On Airs, Waters, and Places
(c. 400 BCE)

I. Whoever wishes to investigate medicine properly should proceed thus: in the first place to consider the seasons of the year, and what effects each of them produces (for they are not at all alike, but differ much from themselves in regard to their changes).[1] Then the winds, the hot and the cold, especially such as are common to all countries, and then such as are peculiar to each locality. We must also consider the qualities of the waters, for as they differ from one another in taste and weight, so also do they differ much in their qualities. In the same manner, when one comes into a city to which he is a stranger, he ought to consider its situation, how it lies to the north or the south, to the rising or to the setting sun. These things one ought to consider most attentively, and concerning the waters which the inhabitants use, whether they be marshy and soft, or hard, and running from elevated and rocky situations, and then if saltish and unfit for cooking;[2] and the ground, whether it be naked and deficient in water, or wooded and well watered, and whether it lies in a hollow, confined situation, or is elevated and cold; and the mode in which the inhabitants live, and what are their pursuits, whether they are fond of drinking and eating to excess, and given to indolence, or are fond of exercise and labor, and not given to excess in eating and drinking.

II. From these things he must proceed to investigate everything else. For if one knows all these things well, or at least the greater part of them, he cannot miss knowing, when he comes into a strange city, either the diseases peculiar to the place, or the particular nature of common diseases, so that he will not be in doubt as to the treatment of the diseases, or commit mistakes, as is likely to be the case provided one had not previously considered these matters. And in particular, as the season and the year advances, he can tell what epidemic diseases will attack the city, either in summer or in winter, and what each individual will be in danger of experiencing from the change of regimen. For knowing the changes of the seasons, the risings and settings of the stars, how each of them takes place, he will be able to know beforehand what sort of a year is going to ensue. Having made these investigations, and knowing beforehand the seasons, such a one must be acquainted with each particular, and must succeed in the preservation of health, and be by no means unsuccessful in the practice of his art. And if it shall be thought that these things belong rather to meteorology, it will be admitted, on second thoughts, that astronomy contributes not a little, but a very great deal, indeed, to medicine. For with the seasons the digestive organs of men undergo a change.

III. But how of the aforementioned things should be investigated and explained, I will now declare in a clear manner. A city that is exposed to hot winds (these are between the wintry rising, and the wintry setting of the sun), and to which these are peculiar, but which is sheltered from the north winds; in such a city the waters will be plenteous and saltish, and as they run from an elevated source, they are necessarily hot in summer, and cold in winter; the heads of the inhabitants are of a humid and pituitous[3] constitution, and their bellies subject to frequent disorders, owing to the phlegm running down from the head; the forms of their bodies, for the most part, are rather flabby; they do not eat nor drink much; drinking wine in particular, and more especially if carried to intoxication, is oppressive to them; and the following diseases are peculiar to the district: in the first place, the women are sickly and subject to excessive menstruation; then many are unfruitful from disease, and not from nature, and they have frequent miscarriages; infants are subject to attacks of convulsions and asthma, which they consider to be connected with infancy, and hold to be a sacred disease (epilepsy).[4] The men are subject to attacks of dysentery, diarrhea, hepialus,[5] chronic fevers in winter, of epinyctis,[6] frequently, and of hemorrhoids about the anus. Pleurisies, peripneumonies, ardent fevers, and whatever diseases are reckoned acute, do not often occur, for such diseases are not apt to prevail where the bowels are loose. Ophthalmies occur of a humid character, but not of a serious nature, and of short duration, unless they attack epidemically from the change of the seasons. And when they pass their fiftieth year, defluxions supervening from the brain, render them paralytic when exposed suddenly to strokes of the sun, or to cold. These diseases are endemic to them, and, moreover, if any epidemic disease connected with the change of the seasons, prevail, they are also liable to it.

IV. But the following is the condition of cities which have the opposite exposure, namely, to cold winds, between the summer settings and the summer risings of the sun, and to which these winds are peculiar, and which are sheltered from the south and the hot breezes. In the first place the waters are, for the most part, hard cold. The men must necessarily be well braced and slender, and they must have the discharges downwards of the alimentary canal hard, and of difficult evacuation, while those upwards are more fluid, and rather bilious than pituitous. Their heads are sound and hard, and they are liable to burstings (of vessels) for the most part. The diseases which prevail epidemically with them are pleurisies, and those which are called acute diseases. This must be the case when the bowels are bound; and from any causes, many become affected with suppurations in the lungs, the cause of which is the tension of the body, and hardness of the bowels; for their dryness and the coldness of the water dispose them to ruptures (of vessels). Such constitutions must be given to excess of eating, but not of drinking; for it is not possible to be gourmands and drunkards at the same time. Ophthalmies, too, at length supervene; these being of a hard and violent nature, and soon ending in rupture of the eyes; persons under thirty years of age are liable to severe bleedings at the nose in summer; attacks of epilepsy are rare but severe. Such people are likely to be rather long-lived; their ulcers are not attended with serious discharges, nor of a malignant character; in disposition they are rather ferocious than gentle. The diseases I have mentioned are peculiar to the men, and besides they are liable to any common complaint which may be prevailing from the changes of the seasons. But the women, in the first place, are of a hard constitution, from the waters being hard, indigestible, and cold; and their menstrual discharges are not regular, but in small quantity, and painful. Then they have difficult parturition, but are not very subject to abortions. And when they do bring forth children, they are unable to nurse them; for the hardness and indigestible nature of the water puts away their milk. Phthisis[7] frequently supervenes after childbirth, for the efforts of it frequently bring on ruptures and strains. Children while still little are subject to dropsies[8] in the testicle, which disappear as they grow older; in such a town they are late in attaining manhood. It is, as I have now stated, with regard to hot and cold winds and cities thus exposed.

V. Cities that are exposed to winds between the summer and the winter risings of the sun, and those the opposite to them, have the following characters: Those which lie to the rising of the sun are all likely to be more healthy than such as are turned to the north, or those exposed to the hot winds, even if there should not be a furlong between them.[9] In the first place, both the heat and cold are more moderate. Then such waters as flow to the rising sun must necessarily be clear, fragrant, soft, and delightful to drink, in such a city. For the sun in rising and shining upon them purifies them by dispelling the vapors which generally prevail in the morning. The persons of the inhabitants are, for the most part, well colored and blooming, unless some disease counteract. The inhabitants have clear voices, and in temper and intellect are superior to those which are exposed to the north, and all the productions of the country in like manner are better. A city so situated resembles the spring as to moderation between heat and cold, and the diseases are few in number, and of a feeble kind, and bear a resemblance to the diseases which prevail in regions exposed to hot winds. The women there are very prolific, and have easy deliveries. Thus it is with regard to them.

VI. But such cities as lie to the west, and which are sheltered from winds blowing from the east, and which the hot winds and the cold winds of the north scarcely touch, must necessarily be in a very unhealthy situation: in the first place the waters are not clear, the cause of which is, because the mist prevails commonly in the morning, and it is mixed up with the water and destroys its clearness, for the sun does not shine upon the water until he be considerably raised above the horizon. And in summer, cold breezes from the east blow and dews fall; and in the latter part of the day the setting sun particularly scorches the inhabitants, and therefore they are pale and enfeebled, and are partly subject to all the aforesaid diseases, but no one is peculiar to them. Their voices are rough and hoarse owing to the state of the air, which in such a situation is generally impure and unwholesome, for they have not the northern winds to purify it; and these winds they have are of a very humid character, such being the nature of the evening breezes. Such a situation of a city bears a great resemblance to autumn as regards the changes of the day, inasmuch as the difference between morning and evening is great. So it is with regard to the winds that are conducive to health, or the contrary.

VII. And I wish to give an account of the other kinds of waters, namely, of such as are wholesome and such as are unwholesome, and what bad and what good effects may be derived from water; for water contributes much towards health. Such waters then as are marshy, stagnant, and belong to lakes, are necessarily hot in summer, thick, and have a strong smell, since they have no current; but being constantly supplied by rainwater, and the sun heating them, they necessarily want their proper color, are unwholesome and form bile; in winter, they become congealed, cold, and muddy with the snow and ice, so that they are most apt to engender phlegm, and bring on hoarseness; those who drink them have large and obstructed spleens, their bellies are hard, emaciated, and hot; and their shoulders, collar-bones, and faces are emaciated; for their flesh is melted down and taken up by the spleen, and hence they are slender; such persons then are voracious and thirsty; their bellies are very dry both above and below, so that they require the strongest medicines.[10] This disease is habitual to them both in summer and in winter, and in addition they are very subject to dropsies of a most fatal character; and in summer dysenteries, diarrheas, and protracted quartan fevers[11] frequently seize them, and these diseases when prolonged dispose such constitutions to dropsies, and thus prove fatal. These are the diseases which attack them in summer; but in winter younger persons are liable to pneumonia, and maniacal affections; and older persons to ardent fevers, from hardness of the belly. Women are subject to edema and leucophlegmasiae;[12] when pregnant they have difficult deliveries; their infants are large and swelled, and then during nursing they become wasted and sickly, and the lochial discharge after parturition does not proceed properly with the women. The children are particularly subject to hernia, and adults to varices and ulcers on their legs, so that persons with such constitutions cannot be long-lived, but before the usual period they fall into a state of premature old age. And further, the women appear to be with child, and when the time of parturition arrives, the fullness of the belly disappears, and this happens from dropsy of the uterus. Such waters then I reckon bad for every purpose. The next to them in badness are those which have their fountains in rocks, so that they must necessarily be hard, or come from a soil which produces thermal waters, such as those having iron, copper, silver, gold, sulphur, alum, bitumen, or nitre (soda) in them; for all these are formed by the force of heat. Good waters cannot proceed from such a soil, but those that are hard and of a heating nature, difficult to pass by urine, and of difficult evacuation by the bowels. The best are those which flow from elevated grounds, and hills of earth; these are sweet, clear, and can bear a little wine; they are hot in summer and cold in winter, for such necessarily must be the waters from deep wells. But those are most to be commended which run to the rising of the sun, and especially to the summer sun; for such are necessarily more clear, fragrant, and light. But all such as are salty, crude, and harsh, are not good for drink. But there are certain constitutions and diseases with which such waters agree when drunk, as I will explain presently. Their characters are as follows: the best are such as have their fountains to the east; the next, those between the summer risings and settings of the sun, and especially those to the risings; and third, those between the summer and winter settings; but the worst are those to the south, and the parts between the winter rising and setting, and those to the south are very bad, but those to the north are better. They are to be used as follows: whoever is in good health and strength need not mind, but may always drink whatever is at hand. But whoever wishes to drink the most suitable for any disease, may accomplish his purpose by attending to the following directions: To persons whose bellies are hard and easily burnt up, the sweetest, the lightest, and the most limpid waters will be proper; but those persons whose bellies are soft, loose, and pituitous, should choose the hardest, those kinds that are most crude, and the saltiest, for thus will they be most readily dried up; for such waters as are adapted for boiling, and are of a very solvent nature, naturally loosen readily and melt down the bowels; but such as are intractable, hard, and by no means proper for boiling, these rather bind and dry up the bowels. People have deceived themselves with regard to salt waters, from inexperience, for they think these waters purgative, whereas they are the very reverse; for such waters are crude, and ill adapted for boiling, so that the belly is more likely to be bound up than loosened by them. And thus it is with regard to the waters of springs.

VIII. I will now tell how it is with respect to rain water, and water from snow. Rain waters, then, are the lightest, the sweetest, the thinnest, and the clearest; for originally the sun raises and attracts the thinnest and lightest part of the water, as is obvious from the nature of salts; for the saltish part is left behind owing to its thickness and weight, and forms salts; but the sun attracts the thinnest part, owing to its lightness, and he abstracts this not only from the lakes, but also from the sea, and from all things which contain humidity, and there is humidity in everything; and from man himself the sun draws off the thinnest and lightest part of the juices. As a strong proof of this, when a man walks in the sun, or sits down having a garment on, whatever parts of the body the sun shines upon do not sweat, for the sun carries off whatever sweat makes its appearance; but those parts which are covered by the garment, or anything else, sweat, for the particles of sweat are drawn and forced out by the sun, and are preserved by the cover so as not to be dissipated by the sun; but when the person comes into the shade the whole body equally perspires, because the sun no longer shines upon it. Wherefore, of all kinds of water, these spoil the soonest; and rain water has a bad spot smell, because its particles are collected and mixed together from most objects, so as to spoil the soonest. And in addition to this, when attracted and raised up, being carried about and mixed with the air, whatever part of it is turbid and darkish is separated and removed from the other, and becomes cloud and mist, but the most attenuated and lightest part is left, and becomes sweet, being heated and concocted by the sun, for all other things when concocted become sweet. While dissipated then and not in a state of consistence it is carried aloft. But when collected and condensed by contrary winds, it falls down wherever it happens to be most condensed. For this is likely to happen when the clouds being carried along and moving with a wind which does not allow them to rest, suddenly encounters another wind and other clouds from the opposite direction: there it is first condensed, and what is behind is carried up to the spot, and thus it thickens, blackens, and is conglomerated, and by its weight it falls down and becomes rain. Such, to all appearance, are the best of waters, but they require to be boiled and strained; for otherwise they have a bad smell, and occasion hoarseness and thickness of the voice to those who drink them. Those from snow and ice are all bad, for when once congealed, they never again recover their former nature; for whatever is clear, light, and sweet in them, is separated and disappears; but the most turbid and weightiest part is left behind. You may ascertain this in the following manner: If in winter you will pour water by measure into a vessel and expose it to the open air until it is all frozen, and then on the following day bring it into a warm situation where the ice will thaw, if you will measure the water again when dissolved you will find it much less in quantity. This is a proof that the lightest and thinnest part is dissipated and dried up by the congelation, and not the heaviest and thickest, for that is impossible: wherefore I hold that waters from snow and ice, and those allied to them, are the worst of any for all purposes whatever. Such are the characters of rain water, and those from ice and snow.

IX. Men become affected with the stone, and are seized with diseases of the kidneys, strangury,[13] sciatica, and become ruptured, when they drink all sorts of waters, and those from great rivers into which other rivulets run, or from a lake into which many streams of all sorts flow, and such as are brought from a considerable distance. For it is impossible that such waters can resemble one another, but one kind is sweet, another saltish and aluminous, and some flow from thermal springs; and these being all mixed up together disagree, and the strongest part always prevails; but the same kind is not always the strongest, but sometimes one and sometimes another, according to the winds, for the north wind imparts strength to this water, and the south to that, and so also with regard to the others. There must be deposits of mud and sand in the vessels from such waters, and the aforesaid diseases must be engendered by them when drunk, but why not to all I will now explain. When the bowels are loose and in a healthy state, and when the bladder is not hot, nor the neck of the bladder very contracted, all such persons pass water freely, and no concretion forms in the bladder; but those in whom the belly is hot, the bladder must be in the same condition; and when preternaturally heated, its neck becomes inflamed; and when these things happen, the bladder does not expel the urine, but raises its heat excessively. And the thinnest part of it is secreted, and the purest part is passed off in the form of urine, but the thickest and most turbid part is condensed and concreted, at first in small quantity, but afterwards in greater; for being rolled about in the urine, whatever is of a thick consistence it assimilates to itself, and thus it increases and becomes indurated. And when such persons make water, the stone forced down by the urine falls into the neck of the bladder and stops the urine, and occasions intense pain; so that calculous children rub their privy parts and tear at them, as supposing that the obstruction to the urine is situated there. As a proof that it is as I say, persons affected with calculus have very limpid urine, because the thickest and foulest part remains and is concreted. Thus it generally is in cases of calculus. It forms also in children from milk, when it is not wholesome, but very hot and bilious, for it heats the bowels and bladder, so that the urine being also heated undergoes the same change. And I hold that it is better to give children only the most diluted wine, for such will least burn up and dry the veins. Calculi do not form so readily in women, for in them the urethra is short and wide, so that in them the urine is easily expelled; neither do they rub the pudendum with their hands, nor handle the passage like males; for the urethra in women opens direct into the pudendum, which is not the case with men, neither in them is the urethra so wide, and they drink more than children do. Thus, or nearly so, is it with regard to them.

X. And respecting the seasons, one may judge whether the year will prove sickly or healthy from the following observations: If the appearances connected with the rising and setting stars be as they should be; if there be rains in autumn; if the winter be mild, neither very tepid nor unseasonably cold, and if in spring the rains be seasonable, and so also in summer, the year is likely to prove healthy. But if the winter be dry and northerly, and the spring showery and southerly, the summer will necessarily be of a febrile character, and give rise to ophthalmies and dysenteries. For when suffocating heat sets in all of a sudden, while the earth is moistened by the vernal showers, and by the south wind, the heat is necessarily doubled from the earth, which is thus soaked by rain and heated by a burning sun, while, at the same time, men's bellies are not in an orderly state, nor the brain properly dried; for it is impossible, after such a spring, but that the body and its flesh must be loaded with humors, so that very acute fevers will attack all, but especially those of a phlegmatic constitution. Dysenteries are also likely to occur to women and those of a very humid temperament. And if at the rising of the Dogstar[14] rain and wintery storms supervene, and if the etesian winds blow, there is reason to hope that these diseases will cease, and that the autumn will be healthy; but if not, it is likely to be a fatal season to children and women, but least of all to old men; and that convalescents will pass into quartans,[15] and from quartans into dropsies; but if the winter be southerly, showery and mild, but the spring northerly, dry, and of a wintry character, in the first place women who happen to be with child, and whose accouchement should take place in spring, are apt to miscarry; and such as bring forth, have feeble and sickly children, so that they either die presently or are tender, feeble, and sickly, if they live. Such is the case with the women. The others are subject to dysenteries and dry ophthalmies, and some have catarrhs beginning in the head and descending to the lungs. Men of a phlegmatic temperament are likely to have dysenteries; and women, also, from the humidity of their nature, the phlegm descending downwards from the brain; those who are bilious, too, have dry ophthalmies from the heat and dryness of their flesh; the aged, too, have catarrhs from their flabbiness and melting of the veins, so that some of them die suddenly and some become paralytic on the right side or the left. For when, the winter being southerly and the body hot, the blood and veins are not properly constringed; a spring that is northerly, dry, and cold, having come on, the brain when it should have been expanded and purged, by the coryza and hoarseness is then constringed and contracted, so that the summer and the heat occurring suddenly, and a change supervening, these diseases fall out. And such cities as lie well to the sun and winds, and use good waters, feel these changes less, but such as use marshy and pooly waters, and lie well both as regards the winds and the sun, these all feel it more. And if the summer be dry, those diseases soon cease, but if rainy, they are protracted; and there is danger of any sore that there is becoming phagedenic[16] from any cause; and lienteries[17] and dropsies supervene at the conclusion of diseases; for the bowels are not readily dried up. And if the summer be rainy and southerly, and next the autumn, the winter must, of necessity, be sickly, and ardent fevers are likely to attack those that are phlegmatic, and more elderly than forty years, and pleurisies and peripneumonies those that are bilious. But if the summer is parched and northerly, but the autumn rainy and southerly, headache and sphacelus[18] of the brain are likely to occur; and in addition, hoarseness, coryza, coughs, and in some cases, consumption. But if the season is northerly and without water, there being no rain, neither after the Dogstar nor Arcturus;[19] this state agrees best with those who are naturally phlegmatic, with those who are of a humid temperament, and with women; but it is most inimical to the bilious; for they become much parched up, and ophthalmies of a dry nature supervene, fevers both acute and chronic, and in some cases melancholy; for the most humid and watery part of the bile being consumed, the thickest and most acrid portion is left, and of the blood likewise, when these diseases came upon them. But all these are beneficial to the phlegmatic, for they are thereby dried up, and reach winter not oppressed with humors, but with them dried up.

XI. Whoever studies and observes these things may be able to foresee most of the effects which will result from the changes of the seasons; and one ought to be particularly guarded during the greatest changes of the seasons, and neither willingly give medicines, nor apply the cautery to the belly, nor make incisions there until ten or more days be past. Now, the greatest and most dangerous are the two solstices, and especially the summer, and also the two equinoxes, but especially the autumnal. One ought also to be guarded about the rising of the stars, especially of the Dogstar, then of Arcturus, and then the setting of the Pleiades;[20] for diseases are especially apt to prove critical in those days, and some prove fatal, some pass off, and all others change to another form and another constitution. So it is with regard to them.

XII. I wish to show, respecting Asia[21] and Europe, how, in all respects, they differ from one another, and concerning the figure of the inhabitants, for they are different, and do not at all resemble one another. To treat of all would be a long story, but I will tell you how I think it is with regard to the greatest and most marked differences. I say, then, that Asia differs very much from Europe as to the nature of all things, both with regard to the productions of the earth and the inhabitants, for everything is produced much more beautiful and large in Asia; the country is milder, and the dispositions of the inhabitants also are more gentle and affectionate. The cause of this is the temperature of the seasons, because it lies in the middle of the risings of the sun towards the east, and removed from the cold (and heat), for nothing tends to growth and mildness so much as when the climate has no predominant quality, but a general equality of temperature prevails. It is not everywhere the same with regard to Asia, but such parts of the country as lie intermediate between the heat and the cold, are the best supplied with fruits and trees, and have the most genial climate, and enjoy the purest waters, both celestial and terrestrial. For neither are they much burnt up by the heat, nor dried up by the drought and want of rain, nor do they suffer from the cold; since they are well watered from abundant showers and snow, and the fruits of the season, as might be supposed, grow in abundance, both such as are raised from seed that has been sown, and such plants as the earth produces of its own accord, the fruits of which the inhabitants make use of, training them from their wild state and transplanting them to a suitable soil; the cattle also which are reared there are vigorous, particularly prolific, and bring up young of the fairest description; the inhabitants too, are well fed, most beautiful in shape, of large stature, and differ little from one another either as to figure or size; and the country itself, both as regards its constitution and mildness of the seasons, may be said to bear a close resemblance to the spring. Manly courage, endurance of suffering, laborious enterprise, and high spirit, could not be produced in such a state of things either among the native inhabitants or those of a different country, for there pleasure necessarily reigns. For this reason, also, the forms of wild beasts there are much varied.[22] Thus it is, as I think, with the Egyptians and Libyans.

XIII. But concerning those on the right hand of the summer risings of the sun as far as the Palus Maeotis[23] (for this is the boundary of Europe and Asia), it is with them as follows: the inhabitants there differ far more from one another than those I have treated of above, owing to the differences of the seasons and the nature of the soil. But with regard to the country itself, matters are the same there as among all other men; for where the seasons undergo the greatest and most rapid changes, there the country is the wildest and most unequal; and you will find the greatest variety of mountains, forests, plains, and meadows; but where the seasons do not change much there the country is the most even; and, if one will consider it, so is it also with regard to the inhabitants; for the nature of some is like to a country covered with trees and well watered; of some, to a thin soil deficient in water; of others, to fenny and marshy places; and of some again, to a plain of bare and parched land. For the seasons which modify their natural frame of body are varied, and the greater the varieties of them the greater also will be the differences of their shapes.

XIV. I will pass over the smaller differences among the nations, but will now treat of such as are great either from nature, or custom; and, first, concerning the Macrocephali.[24] There is no other race of men which have heads in the least resembling theirs. At first, usage was the principal cause of the length of their head, but now nature cooperates with usage. They think those the most noble who have the longest heads. It is thus with regard to the usage: immediately after the child is born, and while its head is still tender, they fashion it with their hands, and constrain it to assume a lengthened shape by applying bandages and other suitable contrivances whereby the spherical form of the head is destroyed, and it is made to increase in length. Thus, at first, usage operated, so that this constitution was the result of force: but, in the course of time, it was formed naturally; so that usage had nothing to do with it; for the semen comes from all parts of the body, sound from the sound parts, and unhealthy from the unhealthy parts. If, then, children with bald heads are born to parents with bald heads; and children with blue eyes to parents who have blue eyes; and if the children of parents having distorted eyes squint also for the most part; and if the same may be said of other forms of the body, what is to prevent it from happening that a child with a long head should be produced by a parent having a long head? But now these things do not happen as they did formerly, for the custom no longer prevails owing to their intercourse with other men. Thus it appears to me to be with regard to them.

XV. As to the inhabitants of Phasis,[25] their country is fenny, warm, humid, and wooded; copious and severe rains occur there at all seasons; and the life of the inhabitants is spent among the fens; for their dwellings are constructed of wood and reeds, and are erected amidst the waters; they seldom practice walking either to the city or the market, but sail about, up and down, in canoes constructed out of single trees, for there are many canals there. They drink the hot and stagnant waters, both when rendered putrid by the sun, and when swollen with rains. The Phasis itself is the most stagnant of all rivers, and runs the smoothest; all the fruits which spring there are unwholesome, feeble and imperfect growth, owing to the redundance of water, and on this account they do not ripen, for much vapor from the waters overspreads the country. For these reasons the Phasians have shapes different from those of all other men; for they are large in stature, and of a very gross habit of body, so that not a joint nor vein is visible; in color they are sallow, as if affected with jaundice. Of all men they have the roughest voices, from their breathing an atmosphere which is not clear, but misty and humid; they are naturally rather languid in supporting bodily fatigue. The seasons undergo but little change either as to heat or cold; their winds for the most part are southerly, with the exception of one peculiar to the country, which sometimes blows strong, is violent and hot, and is called by them the wind cenchron. The north wind scarcely reaches them, and when it does blow it is weak and gentle. Thus it is with regard to the different nature and shape of the inhabitants of Asia and Europe.

XVI. And with regard to the pusillanimity and cowardice of the inhabitants, the principal reason the Asiatics are more unwarlike and of gentler disposition than the Europeans is, the nature of the seasons, which do not undergo any great changes either to heat or cold, or the like; for there is neither excitement of the understanding nor any strong change of the body whereby the temper might be ruffled and they be roused to inconsiderate emotion and passion, rather than living as they do always in the state. It is changes of all kinds which arouse understanding of mankind, and do not allow them to get into a torpid condition. For these reasons, it appears to me, the Asiatic race is feeble, and further, owing to their laws; for monarchy prevails in the greater part of Asia, and where men are not their own masters nor independent, but are the slaves of others, it is not a matter of consideration with them how they may acquire military discipline, but how they may seem not to be warlike, for the dangers are not equally shared, since they must serve as soldiers, perhaps endure fatigue, and die for their masters, far from their children, their wives, and other friends; and whatever noble and manly actions they may perform lead only to the aggrandizement of their masters, whilst the fruits which they reap are dangers and death; and, in addition to all this, the lands of such persons must be laid waste by the enemy and want of culture. Thus, then, if any one be naturally warlike and courageous, his disposition will be changed by the institutions. As a strong proof of all this, such Greeks or barbarians in Asia as are not under a despotic form of government, but are independent, and enjoy the fruits of their own labors, are of all others the most warlike; for these encounter dangers on their own account, bear the prizes of their own valor, and in like manner endure the punishment of their own cowardice. And you will find the Asiatics differing from one another, for some are better and others more dastardly; of these differences, as I stated before, the changes of the seasons are the cause. Thus it is with Asia.

XVII. In Europe there is a Scythian race, called Sauromatae,[26] which inhabits the confines of the Palus Maeotis, and is different from all other races. Their women mount on horseback, use the bow, and throw the javelin from their horses, and fight with their enemies as long as they are virgins; and they do not lay aside their virginity until they kill three of their enemies, nor have any connection with men until they perform the sacrifices according to law. Whoever takes to herself a husband, gives up riding on horseback unless the necessity of a general expedition obliges her. They have no right breast; for while still of a tender age their mothers heat strongly a copper instrument constructed for this very purpose, and apply it to the right breast, which is burnt up, and its development being arrested, all the strength and fullness are determined to the right shoulder and arm.

XVIII. As the other Scythians have a peculiarity of shape, and do not resemble any other, the same observation applies to the Egyptians, only that the latter are oppressed by heat and the former by cold. What is called the Scythian desert is a prairie, rich in meadows, high-lying, and well watered; for the rivers which carry off the water from the plains are large. There live those Scythians which are called Nomades, because they have no houses, but live in wagons. The smallest of these wagons have four wheels, but some have six; they are covered in with felt, and they are constructed in the manner of houses, some having but a single apartment, and some three; they are proof against rain, snow, and winds. The wagons are drawn by yokes of oxen, some of two and others of three, and all without horns, for they have no horns, owing to the cold. In these wagons the women live, but the men are carried about on horses, and the sheep, oxen, and horses accompany them; and they remain on any spot as long as there is provender for their cattle, and when that fails they migrate to some other place. They eat boiled meat, and drink the milk of mares, and also eat hippace, which is cheese prepared from the milk of the mare. Such is their mode of life and their customs.[27]

XIX. In respect of the seasons and figure of body, the Scythian race, like the Egyptian, have a uniformity of resemblance, different from all other nations; they are by no means prolific, and the wild beasts which are indigenous there are small in size and few in number, for the country lies under the Northern Bears,[28] and the Rhiphaean mountains,[29] whence the north wind blows; the sun comes very near to them only when in the summer solstice, and warms them but for a short period, and not strongly; and the winds blowing from the hot regions of the earth do not reach them, or but seldom, and with little force; but the winds from the north always blow, congealed, as they are, by the snow, ice, and much water, for these never leave the mountains, which are thereby rendered uninhabitable. A thick fog covers the plains during the day, and amidst it they live, so that winter may be said to be always present with them; or, if they have summer, it is only for a few days, and the heat is not very strong. Their plains are high-lying and naked, not crowned with mountains, but extending upwards under the Northern Bears. The wild beasts there are not large, but such as can be sheltered underground; for the cold of winter and the barrenness of the country prevent their growth, and because they have no cover nor shelter. The changes of the seasons, too, are not great nor violent, for, in fact, they change gradually; and therefore their figures resemble one another, as they all equally use the same food, and the same clothing summer and winter, respiring a humid and dense atmosphere, and drinking water from snow and ice; neither do they make any laborious exertions, for neither body nor mind is capable of enduring fatigue when the changes of the seasons are not great. For these reasons their shapes are gross and fleshy, with ill-marked joints, of a humid temperament, and deficient in tone: the internal cavities, and especially those of the intestines, are full of humors; for the belly cannot possibly be dry in such a country, with such a constitution and in such a climate; but owing to their fat, and the absence of hairs from their bodies, their shapes resemble one another, the males being all alike, and so also with the women; for the seasons being of a uniform temperature, no corruption or deterioration takes place in the concretion of the semen, unless from some violent cause, or from disease.

XX. I will give you a strong proof of the humidity of their constitutions. You will find the greater part of the Scythians, and all the Nomades, with marks of the cautery on their shoulders, arms, wrists, breasts, hip-joints, and loins, and that for no other reason but the humidity and flabbiness of their constitution, for they can neither strain with their bows, nor launch the javelin from their shoulder owing to their humidity and atony: but when they are burnt, much of the humidity in their joints is dried up, and they become better braced, better fed, and their joints get into a more suitable condition. They are flabby and squat at first, because, as in Egypt, they are not swathed; and then they pay no attention to horsemanship, so that they may be adept at it; and because of their sedentary mode of life; for the males, when they cannot be carried about on horseback, sit the most of their time in the wagon, and rarely practice walking, because of their frequent migrations and shiftings of situation; and as to the women, it is amazing how flabby and sluggish they are. The Scythian race are tawny from the cold, and not from the intense heat of the sun, for the whiteness of the skin is parched by the cold, and becomes tawny.

XXI. It is impossible that persons of such a constitution could be prolific, for, with the man, the sexual desires are not strong, owing to the laxity of his constitution, the softness and coldness of his belly, from all which causes it is little likely that a man should be given to venery;[30] and besides, from being jaded by exercise on horseback, the men become weak in their desires. On the part of the men these are the causes; but on that of the women, they are embonpoint and humidity; for the womb cannot take in the semen, nor is the menstrual discharge such as it should be, but scanty and at too long intervals; and the mouth of the womb is shut up by fat and does not admit the semen; and, moreover, they themselves are indolent and fat, and their bellies cold and soft. From these causes the Scythian race is not prolific. Their female servants furnish a strong proof of this; for they no sooner have connection with a man than they prove with child, owing to their active course of life and the slenderness of body.

XXII. And, in addition to these, there are many eunuchs among the Scythians, who perform female work, and speak like women. Such persons are called effeminates. The inhabitants of the country attribute the cause of their impotence to a god, and venerate and worship such persons, every one dreading that the like might befall himself; but to me it appears that such affections are just as much divine as all others are, and that no one disease is either more divine or more human than another, but that all are alike divine, for that each has its own nature, and that no one arises without a natural cause. But I will explain how I think that the affection takes its rise. From continued exercise on horseback they are seized with chronic defluxions in their joints owing to their legs always hanging down below their horses; they afterwards become lame and stiff at the hip-joint, such of them, at least, as are severely attacked with it. They treat themselves in this way: when the disease is commencing, they open the vein behind either ear, and when the blood flows, sleep, from feebleness, seizes them, and afterwards they awaken, some in good health and others not. To me it appears that the semen is altered by this treatment, for there are veins behind the ears which, if cut, induce impotence; now, these veins would appear to me to be cut. Such persons afterwards, when they go in to women and cannot have connection with them, at first do not think much about it, but remain quiet; but when, after making the attempt two, three, or more times, they succeed no better, fancying they have committed some offence against the god whom they blame for the affection, they put on female attire, reproach themselves for effeminacy, play the part of women, and perform the same work as women do. This the rich among the Scythians endure, not the basest, but the most noble and powerful, owing to their riding on horseback; for the poor are less affected, as they do not ride on horses. And yet, if this disease had been more divine than the others, it ought not to have befallen the most noble and the richest of the Scythians alone, but all alike, or rather those who have little, as not being able to pay honors to the gods, if, indeed, they delight in being thus rewarded by men, and grant favors in return; for it is likely that the rich sacrifice more to the gods, and dedicate more votive offerings, inasmuch as they have wealth, and worship the gods; whereas the poor, from want, do less in this way, and, moreover, upbraid the gods for not giving them wealth, so that those who have few possessions were more likely to bear the punishments of these offences than the rich. But, as I formerly said, these affections are divine just as much as others, for each springs from a natural cause, and this disease arises among the Scythians from such a cause as I have stated. But it attacks other men in like manner, for whenever men ride much and very frequently on horseback, then many are affected with rheums in the joints, sciatica, and gout, and they are inept at venery.[30] But these complaints befall the Scythians, and they are the most impotent of men for the aforesaid causes, and because they always wear breeches, and spend the most of their time on horseback, so as not to touch their privy parts with the hands, and from the cold and fatigue they forget the sexual desire, and do not make the attempt until after they have lost their virility. Thus it is with the race of the Scythians.

XXIII. The other races in Europe differ from one another, both as to stature and shape, owing to the changes of the seasons, which are very great and frequent, and because the heat is strong, the winters severe, and there are frequent rains, and again protracted droughts, and winds, from which many and diversified changes are induced. These changes are likely to have an effect upon generation in the coagulation of the semen, as this process cannot be the same in summer as in winter, nor in rainy as in dry weather; wherefore, I think, that the figures of Europeans differ more than those of Asiatics; and they differ very much from one another as to stature in the same city; for vitiations of the semen occur in its coagulation more frequently during frequent changes of the seasons, than where they are alike and equable. And the same may be said of their dispositions, for the wild, and unsociable, and the passionate occur in such a constitution; for frequent excitement of the mind induces wildness, and extinguishes sociableness and mildness of disposition, and therefore I think the inhabitants of Europe more courageous than those of Asia; for a climate which is always the same induces indolence, but a changeable climate, laborious exertions both of body and mind; and from rest and indolence cowardice is engendered, and from laborious exertions and pains, courage. On this account the inhabitants of Europe are [more courageous, Ed.] than the Asiatics, and also owing to their institutions, because they are not governed by kings like the latter, for where men are governed by kings there they must be very cowardly, as I have stated before; for their souls are enslaved, and they will not willingly, or readily undergo dangers in order to promote the power of another; but those that are free undertake dangers on their own account, and not for the sake of others; they court hazard and go out to meet it, for they themselves bear off the rewards of victory, and thus their institutions contribute not a little to their courage. Such is the general character of Europe and Asia.

XIV. And there are in Europe other tribes, differing from one another in stature, shape, and courage: the differences are those I formerly mentioned, and will now explain more clearly. Such as inhabit a country which is mountainous, rugged, elevated, and well watered, and where the changes of the seasons are very great, are likely to have great variety of shapes among them, and to be naturally of an enterprising and warlike disposition; and such persons are apt to have no little of the savage and ferocious in their nature; but such as dwell in places which are low-lying, abounding in meadows and ill ventilated, and who have a larger proportion of hot than of cold winds, and who make use of warm waters—these are not likely to be of large stature nor well proportioned, but are of a broad make, fleshy, and have black hair; and they are rather of a dark than of a light complexion, and are less likely to be phlegmatic than bilious; courage and laborious enterprise are not naturally in them, but may be engendered in them by means of their institutions. And if there be rivers in the country which carry off the stagnant and rain water from it, these may be wholesome and clear; but if there be no rivers, but the inhabitants drink the waters of fountains, and such as are stagnant and marshy, they must necessarily have prominent bellies and enlarged spleens. But such as inhabit a high country, and one that is level, windy, and well-watered, will be large of stature, and like to one another; but their minds will be rather unmanly and gentle. Those who live on thin, ill-watered, and bare soils, and not well attempered in the changes of the seasons, in such a country they are likely to be in their persons rather hard and well braced, rather of a blond than a dark complexion, and in position and passions haughty and self-willed. For, where the changes of the seasons are most frequent, and where they differ most from one another, there you will find their forms, dispositions, and nature the most varied. These are the strongest of the natural causes of difference, and next the country in which one lives, and the waters; for, in general, you will find the forms and dispositions of mankind to correspond with the nature of the country; for where the land is fertile, soft, and well-watered, and supplied with waters from very elevated situations, so as to be hot in summer and cold in winter, and where the seasons are fine, there the men are fleshy, have ill-formed joints, and are of a humid temperament; they are not disposed to endure labor, and, for the most part, are base in spirit; indolence and sluggishness are visible in them, and to the arts they are dull, and not clever nor acute. When the country is bare, not fenced, and rugged, blasted by the winter and scorched by the sun, there you may see the hardy, slender, with well-shaped joints, well-braced, and shaggy; sharp, industry and vigilance accompany such a constitution; in morals and passions they are haughty and opinionative, inclining rather to the fierce than to the mild; and you will find them acute and ingenious as regards the arts, and excelling in military affairs; and likewise all the other productions of the earth corresponding to the earth itself. Thus it is with regard to the most opposite natures and shapes; drawing conclusions from them, you may judge of the rest without any risk of error.

FINIS

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CHAPTER 2

JOHN GRAUNT
(1620–1674)

[T]here is much pleasure in deducing so many abstruse, and unexpected inferences out of these poor despised Bills of Mortality.

—John Graunt, *Natural and Political Observations*, 1662

John Graunt (pronounced "Grant"), born in London at the sign of the Seven Stars in Burchin Lane in 1620, was the firstborn son of Hampshire-raised draper Henry Graunt and his wife Mary. John's siblings numbered six or seven. In 1636, at the age of 16, John was apprenticed as a haberdasher. He taught himself French and Latin before opening the shop each day and generally pursued the path to a successful career. Upon completion of his 5-year apprenticeship in 1641, John married Mary Scott, with whom he had four children. His son died in Persia, and at least one of his three daughters became a nun.

A highly successful merchant by his thirtieth birthday, Graunt pursued his interests in art and politics. By this time, he had secured enough wealth to arrange for his friend William Petty to be accorded the professorship of music at Gresham College. Graunt was known in London as an important collector of prints, and he retained friendships with miniaturist Samuel Cooper and portrait painter John Hayls (Hales). He also held multiple offices in the Drapers' Company, the ward offices of the city, and was elected to the Common Council, as well as serving as major in the militia. He was known as a good mediator and arbitrator of conflicts among his fellow merchants.

At some point in his adult life, Graunt developed a keen interest in the Bills of Mortality for the city of London and its environs, putting the Bills together for "long and serious perusal." The Bills began to be published weekly in 1604 in order to track the plague epidemic, a serious concern until the Great Fire of 1666. But the Bills had never been thoroughly analyzed. Although he had no formal education in mathematics, Graunt systematically tabulated the Bills and examined them for statistical patterns. He was sufficiently satisfied with his work to publish *Observations* in 1662. In February of that year, Graunt presented 50 copies of his work to the Society of Philosophers (the Royal Society), whose members he dubbed in the introduction "those Noble *Virtuosi* of *Gresham-Colledge*."

Whether it was the sheer volume of information presented, his insightful conclusions, or a letter from the king recommending him to membership, Graunt was proposed as a candidate for admission to the society, elected, and served as an active member from 1664 to 1666.

The Great Fire of London seems to have been a turning point in Graunt's life. He lost his home, and his business suffered significantly. His friend Sir William Petty seems to have helped with some of his bills, but Graunt died of jaundice just before Easter on April 18, 1674, still in poverty. His widow was granted a pension from the Drapers' Company, owing to need. Graunt's body was buried in St. Dunstan's Church. As the church has since been relocated, his final resting place remains uncertain.

A Note on the Text

Reading *Observations* can be challenging. The work includes many unfamiliar causes of death and nonstandard word usage that even confused Graunt. For example, the author notes the problem of not having a set of definitions by which to sort his data. He bemoaned the problems of data reliability, especially as it relates to underreporting and co-morbidity. Graunt also noted that changes in the way data for the Bills were gathered over time might be at the root of changes in the patterns of mortality. Clearly, if people had to pay to have their children's christening listed in a registry, some might have chosen to pass up the opportunity.

We learn from *Observations* that people were not dying of starvation in London in Graunt's time, not even the beggars. The work tells us that (1) there were more male than female births and that the male/female birth ratio was stable; (2) infant mortality was high; and (3) there was seasonal variation in mortality—facts that still hold true today. Finally, Graunt is credited with creating one of the first life tables, the cornerstone of actuarial science and the life insurance industry. Assembling a life table from the Bills was no small feat, as the documents did not record a person's age at the time of his or her death. In order to estimate age, Graunt noted that about 36 percent of all deaths were for causes of death that applied mainly to children under the age of six, his starting point for the life table. While his table was "guesstimated," it is today considered quite accurate for the population of London in Graunt's time.

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Natural and Political Observations Mentioned in a Following Index, and Made Upon the Bills of Mortality
(1662, Abridged)

[Graunt's work begins with several pages of dedications to John Lord Roberts and Sir Robert Moray, as well as an "Index of the *Positions*, *Observations*, and *Questions* contained in this Discourse." These have not been reprinted here to save space. Ed.]

The Preface

Having been born, and bred in the City of *London*, and having always observed, that most of them who constantly took in the weekly Bills of *Mortality*, made little other use of them, then to look at the foot, how the *Burials* increase, or decrease; And, among the *Casualties*, what had happened rare, and extraordinary in the week currant; so as they might take the same as a *Text* to talk upon, in the next Company; and withall, in the *Plague-time*, how the *Sickness* increased, or decreased, that so the *Rich* might judge of the necessity of their removall, and *Trades-men* might conjecture what doings they were like to have in their respective dealings:

2. Now, I thought that the Wisdom of our City had certainly designed the laudable practice of takeing, and distributing these Accompts, for other, and greater uses then those above-mentioned, or at least, that some other uses might be made of them. And thereupon I casting mine Eye upon so many of the General *Bills,* as next came to hand, I found encouragement from them, to look out all the *Bills* I could, and (to be short) to furnish my self with as much matter of that kind, even as the Hall of the *Parish-Clerks* could afford me; the which, when I had reduced into Tables (the Copies whereof are here inserted) so as to have a view of the whole together, in order to the more ready comparing of one *Year, Season, Parish,* or other *Division* of the City, with another, in respect of all the *Burials,* and *Christnings,* and of all the *Diseases,* and *Casualties* happening in each of them respectively; I did then begin, not onely to examine the Conceits, Opinions, and Conjectures, which upon view of a few scattered *Bills* I had taken up; but did also admit new ones, as I found reason, and occasion from my *Tables.*

3. Moreover, finding some *Truths,* and not commonly believed Opinions, to arise from my Meditations upon these neglected *Papers,* I proceeded farther, to consider what benefit the knowledge of the same would bring to the World; that I might not engage my self in idle, and useless

Speculations, but like those Noble *Virtuosi* of *Gresham-Colledge* (who reduce their subtile Disquisitions upon Nature into downright Mechanical uses) present the World with some real fruit from those ayrie Blossoms.

4. How far I have succeeded in the Premisses, I now offer to the World's censure. Who, I hope will not expect from me, not professing Letters, things demonstrated with the same certainty, wherewith Learned men determine in their *Scholes*; but will take it well, that I should offer at a new thing, and could forbear presuming to meddle where any of the Learned Pens have ever touched before, and that I have taken the pains, and been at the charge, of setting out those *Tables,* whereby all men may both correct my *Positions,* and raise others of their own: For herein I have, like a silly Scholeboy, coming to say my Lesson to the World (that Peevish, and Tetchie Master) brought a bundle of Rods wherewith to be whipt, for every mistake I have committed.

CHAPTER I
Of the Bills of Mortality, their beginning, and progress

The first of the continued weekly *Bills of Mortality* extant at the Parish-Clerks *Hall,* begins the 29 of *December,* 1603, being the first year of King *James* his Reign; since when, a weekly Accompt hath been kept there of *Burials* and *Christnings*. It is true, There were *Bills* before, *viz*. for the years 1592, –93, –94, but so interrupted since, that I could not depend upon the sufficiencie of them, rather relying upon those Accompts which have been kept since, in order, as to all the uses I shall make of them.

2. I believe, that the rise of keeping these Accompts, was taken from the *Plague:* for the said *Bills* (for ought appears) first began in the said year 1592, being a time of great *Mortality;* And after some disuse, were resumed again in the year 1603, after the *Plague* then happening likewise.

3. These *Bills* were Printed and published, not onely every week on *Thursdays,* but also a general Accompt of the whole Year was given in, upon the *Thursday* before *Christmas Day:* which said general Accompts have been presented in the several manners following, *viz.* from the Year 1603, to the Year 1624, *inclusive,* according to the Pattern here inserted.

1623 1624

The generall *Bill* for the whole Year, of all the *Burials* and *Christnings,* as well within the City of *London,* and the Liberties thereof, as in the Nine out-Parishes adjoyning to the City, with the *Pest-house* belonging to the same: From *Thursday* the 18 of *December*, 1623, to *Thursday* the 16 of *December,*

1624. According to the Report made to the King's most Excellent Majesty, by the Company of the Parish-Clerks of *London*.

Buried this Year in the fourscore and seventeen Parishes of *London* within the walls	3386
Whereof, of the Plague	1
Buried this Year in the sixteen Parishes of *London*, and the *Pest-house,* being within the Liberties, and without the walls	5924
Whereof, of the Plague	5
The whole sum of all the Burials in *London,* and the Liberties thereof, is this Year	9310
Whereof, of the Plague	6
Buried of the Plague without the Liberties, in *Middlesex,* and *Surrey* this whole Year	0
Christned in *London,* and the Liberties thereof, this Year	6368
Buried this Year in the Nine out-Parishes, adjoyning to *London,* and out of the freedom	2900
Whereof, of the Plague	5
The Total of all the Burials in the places aforesaid, is	12210
Whereof, of the Plague	11
Christned in all the aforesaid places this Year	8299
Parishes clear of the Plague	116
Parishes that have been Infected this Year	6

4. In the Year 1625, every Parish was particularized, as in the following *Bill*: where note, that this next year of Plague caused the Augmentation, and Correction of the *Bills*; as the former year of Plague, did the very being of them.

1624 1625

A general, or great Bill for this Year, of the whole number of Burials, which have been buried of all Diseases, and also of the *Plague* in every Parish within the City of *London,* and the Liberties thereof; as also in the nine out-Parishes adjoyning to the said City; with the Pest-house belonging to the same. From *Thursday* the 16 day of *December,* 1624 to *Thursday* the 15 day of *December,* 1625. According to the Report, made to the king's most Excellent Majesty, by the Company of Parish-Clerks of *London*.

London	Bur.	Plag.	London	Bur.	Plag.
Albanes in Woodstreet	188	78	Katherine Coleman	263	175
Alhallows Barking	397	263	Katherine Cree-church	886	373
Alhallows Breadstreet	34	14	Lawrence in the Jewrie	91	55
Alhallows the Great	442	302	Lawrence Pountney	206	127
Alhallows Hony-lane	18	8	Leonards Eastcheap	55	26
Alhallows the less	259	205	Leonards Fosterlane	292	209
Alhal. in Lumberdstreet	86	44	Magnus Parish by Bridge	137	85
Alhallows Stainings	183	138	Margarets Lothbury	114	64
Alhallows the Wall	301	155	Margarets Moses	37	25
Alphage Cripple-Gate	240	190	Margarets new Fishstreet	123	82
Andrew-Hubbard	146	101	Margarets Pattons	77	50
Andrews Undershaft	219	149	Mary Ab-church	98	58
Andrews by Wardrobe	373	191	Mary Aldermanbury	126	79
Annes at Aldersgate	196	128	Mary Aldermary	92	54
Annes Black-Friers	336	215	Mary le Bow	35	19
Antholins Parish	62	31	Mary Bothaw	22	14
Austins Parish	72	40	Mary Colechurch	26	11
Barthol. at the Exchange	52	24	Mary at the Hill	152	84
Bennets Fink	108	57	Mary Mounthaw	76	58
Bennets Grace-Church	48	14	Mary Sommerset	270	192
Bennnets at Pauls Wharf	226	131	Mary Stainings	70	44
Bennets Sherehog	24	8	Mary Woolchurch	58	25
Botolps Billings-gate	99	66	Mary Woolnoth	82	50
Christ's-Church Parish	611	371	Martins Ironmonger-lane	25	18
Christopher's Parish	48	28	Martins at Ludgate	254	164
Clements by Eastcheap	87	72	Martins Orgars	88	47
Dyonis Black-Church	99	59	Martins Outwich	60	30

(*continued*)

(*continued*)

London	Bur.	Plag.	London	Bur.	Plag.
Dunstans in the East	335	225	Martins in the Vintry	339	208
Edmunds Lumberdstreet	78	49	Matthew Fridaystreet	24	11
Ethelborow in Bishopag	205	101	Maudlins in Milkstreet	401	23
St. Faiths	89	45	Maudlins Oldfish-street	225	142
St. Fosters in Foster-lane	149	102	Michael Bassishaw	199	139
Gabriel Fen church	71	54	Michael Corn-Hill	159	79
George Butlophs-lane	30	19	Michael Crooked-lane	144	91
Gregories by Pauls	296	196	Michael Queenhithe	215	157
Hellens in Bishopsgate st.	136	71	Michael in the Quern	53	30
James by Garlickhithe	180	109	Michael in the Ryal	111	61
John Baptist	122	79	Michael in Woodstreet	189	68
John Evangelist	7	0	Mildreds Breadstreet	60	44
John Zacharies	143	97	Mildreds Poultrey	94	45
James Duke place	310	254	Nicholas Aeons	33	13
Nicholas Cole-Abby	87	67	Peters at Pauls Wharf	97	68
Nicholas Olaves	70	43	Peters poor in Broad-street	52	27
Olaves in Hartstreet	266	195	Stevens in Coleman-street	506	350
Olaves in the Jewry	43	25	Stevens in Walbrook	25	13
Olaves in Silverstreet	174	103	Swithins at London-stone	99	60
Pancras by Soperlane	17	8	Thomas Apostles	141	107
Peter in Cheap	68	44	Trinity Parish	148	87
Peters in Corn-hill	318	78			
Buried within the 97 Parishes within the Walls of, all Diseases					14340
Whereof, of the Plague					9197

Andrews in Holborn	2190	1636	Georges Southwark	1608	912
Bartholmew the Great	516	360	Giles Cripplegate	3988	2338
Bartholmew the less	111	65	Olaves in Southwark	3689	2609
Brides Parish	1481	1031	Saviours in Southwark	2746	1671
Botolph Algate	2573	1653	Sepulchres Parish	3425	2420
Bridewel Precinct	213	152	Thomas in Southwark	335	277
Bottolph Bishopgate	2334	714	Trinity in the Minories	131	87
Botolph Aldergate	578	307	At the Pesthouse	194	189
Dunstanes the West	860	642			
Buried in the 16 Parishes without the Walls, standing part within the Liberties, and part without: in Middlesex, and Surrey, and at the Pesthouse					26972
Whereof, of the Plague					17153

Buried in the nine out-Parishes.

Clements Templebar	1284	755	Martins in the Fields	1470	973
Giles in the Fields	1333	947	Mary White-chappel	3305	2272
James at Clarkenwell	1191	903	Magdalens Bermondsey	1127	889
Katherins by the Tower	998	744	Savoy Parish	250	176
Leonards in Shorditch	1995	1407			
Buried in the nine out Parishes, in Middlesex, and Surrey					12953
Whereof, of the Plague					9067

The Total of all the Burials of all Diseases, within the Walls, without the Walls, in the Liberties in Middlesex and Surrey; with the nine Out Parishes and the Pest-house	54265
Whereof, Buried of the Plague, this present year, is	35417
Christnings this present year, is	6983
Parishes clear this year, is	1
Parishes infected this year, is	121

5. In the Year 1626, the City of *Westminster* in imitation of *London,* was inserted. The grosse accompt of the *Burials,* and *Christnings,* with distinction of the *Plague* being only taken notice of therein; the fifth, or last Canton, or Lined-space, of the said Bill, being varyed into the form following, *viz.*

In *Westminster* this Year	*Buried*	471
	Plague	13
	Christenings	361

6. In the Year 1629, an accompt of the *Diseases,* and *Casualties* whereof any dyed, together with the distinction of *Males* and *Females,* making the sixth Canton of the Bill, was added in manner following.

The Canton of Casualties, *and of the Bill for the Year* 1639. *being of the same forme with that of* 1629.

The Diseases, and Casualties this year being 1632			
Abortive and Stillborn	445	Jaundies[1]	43
Affrighted[2]	1	Jawfaln[3]	8
Aged	628	Impostume[4]	74
Ague[5]	43	Kil'd by several accidents	46
Apoplex[6] and Meagrom[7]	17	King's Evil[8]	38
Bit with a mad dog[9]	1	Lethargie[10]	2
Bleeding	3	Livergrown[11]	87
Bloody flux, scowring, and flux[12]	348	Lunatique	5
Brused, Issues, sores, and ulcers	28	Made away themselves[13]	15
Burnt, and Scalded	5	Measles	80
Burst and Rupture	9	Murthered	7
Cancer and Wolf[14]	10	Over-laid, and starved at nurse[15]	7
Canker[16]	1	Palsie[17]	25
Childbed[18]	171	Piles[19]	1
Chrisomes[20] and Infants	2268	Plague	8
Cold, and Cough	55	Planet[21]	13
Colick, Stone[22] and Strangury[23]	56	Pleurisie and Spleen	36

The Diseases, and Casualties this year being 1632			
Consumption[24]	1797	Purples and Spotted Feaver[25]	38
Convulsion	241	Quinsie[26]	7
Cut of the Stone[27]	5	Rising of the Lights[28]	98
Dead in the street, and starved	6	Sciatica[29]	1
Dropsie[30] and Swelling	267	Scurvey and Itch[31]	9
Drowned	34	Suddenly	62
Executed, and prest to death	18	Surfet[32]	86
Falling Sickness[33]	7	Swine Pox[34]	6
Fever	1108	Teeth	470
Fistula	13	Thrush, and Sore mouth	40
Flocks, and small Pox	531	Tympany[35]	13
French Pox[36]	12	Tissick[37]	34
Gangrene	5	Vomiting	1
Gout	4	Worms	27
Grief	11		

Christened	Males	4994	Buried	Males	4932	Whereof, of the Plague - 8
	Females	4590		Females	4603	
	In all	9584		In all	9535	

Increased in the Burials in the 122 Parishes, and at the Pest-house this year	993
Decreased of the Plague in the 122 Parishes, and at the Pest-house this year	266

7. In the year 1636, the Accompt of the *Burials*, and *Christenings* in the Parishes of *Islington, Lambeth, Stepney, Newington, Hackney,* and *Redriff,* were added in the manner following, making a seventh Canton, *viz.*

8. *Covent Garden* being made a Parish, the nine out-Parishes were called the ten out-Parishes, the which in former years were but eight.

9. In the year 1660, the last-mentioned ten Parishes, with *Westminster, Islington, Lambeth, Stepney, Newington, Hackney,* and *Redriff,* are en-

In Margaret Westminster	Christned Buried Plague	440 890 0	Newington	Christned Buried Plague	99 181 0
Islington	Christned Buried Plague	36 131 0	Hackney	Christned Buried Plague	30 91 0
Lambeth	Christned Buried Plague	132 220 0			
Stepney	Christned Buried Plague	892 1486 0	Redriff	Christned Buried Plague	16 48 0
The total of all the Burials in the seven last Parishes this Year					2958
Whereof of the Plague					0
The total of all the Christnings					1645

tered under two Divisions, *viz.* the one containing the twelve Parishes lying in *Middlesex,* and *Surrey,* and the other the five Parishes within the City, and Liberties of *Westminster, viz.* St. *Clement-Danes,* St. *Paul's-Covent-Garden,* St. *Martin's* in the *Fields,* St. *Mary-Savoy,* and St. *Margaret's Westminster.*

10. We have hitherto described the several steps, whereby the *Bills of Mortality* are come up to their present state; we come next to shew how they are made, and composed, which is in this manner, *viz.* When any one dies, then, either by tolling, or ringing of a Bell, or by bespeaking of a Grave of the *Sexton,* the same is known to the *Searchers,* corresponding with the said *Sexton.*

11. The *Searchers* hereupon (who are antient Matrons, sworn to their office) repair to the place, where the dead Corps lies, and by view of the same, and by other enquiries, they examine by what *Disease,* or *Casualty* the Corps died. Hereupon they make their Report to the *Parish-Clerk,* and he, every *Tuesday* night, carries in an Accompt of all the *Burials,* and *Christnings,* hapning that Week, to the *Clerk* of the *Hall.* On *Wednesday* the general Accompt is made up, and Printed, and on *Thursdays* published, and dispersed to the several Families, who will pay four shillings *per Annum* for them.

12. *Memorandum,* That although the general yearly *Bills* have been set out in the several varieties aforementioned, yet the Original Entries in the *Hall-books* were as exact in the very first Year as to all particular, as now; and the specifying of *Casualties* and *Diseases,* was probably more.

CHAPTER II
General Observations upon the Casualties

In my Discourses upon the *Bills* I shall first speak of the *Casualties,* then give my Observations with reference to the *Places,* and *Parishes* comprehended in the *Bills;* and next of the *Years,* and *Seasons.*

1. There seems to be good reason, why the *Magistrate* should himself take notice of the numbers of *Burials,* and *Christnings, viz.* to see, whether the City increase or decrease in people; whether it increase proportionably with the rest of the Nation; whether it be grown big enough, or too big, *&c.* But why the same should be made know [*sic*] to the People, otherwise then to please them as with a curiosity, I see not.

2. Nor could I ever yet learn (from the many I have asked, and those not of the least *Sagacity*) to what purpose the distinction between *Males* and *Females* is inserted, or at all taken notice of; or why that of *Marriages* was not equally given in? Nor is it obvious to everybody, why the accompt of the *Casualties* (whereof we are now speaking) is made? The reason, which seems most obvious for this latter, is, That the state of health in the City may at all times appear.

3. Now it may be Objected, That the same depends most upon the Accompts of *Epidemical Diseases,* and upon the chief of them all, the *Plague;* wherefore the mention of the rest seems onely matter of curiosity.

4. But to this we answer; That the knowledge even of the numbers, which die of the *Plague,* is not sufficiently deduced from the meer Report of the *Searchers,* which onely the Bills afford; but from other Rationcinations, and comparings of the *Plague* with some other *Casualties.*

5. For we shall make it probable, that in Years of *Plague* a quarter part more dies of that *Disease* than are set down; the same we shall also prove by the other *Casualties.* Wherefore, if it be necessary to impart to the World a good Accompt of some few *Casualties,* which since it cannot well be done without giving an Accompt of them all, then is our common practice of doing so very apt, and rational.

6. Now, to make these Corrections upon the perhaps, ignorant, and careless *Searchers* Reports, I considered first of what Authority they were in themselves, that is, whether any credit at all were to be given to their

Distinguishments: and finding that many of the *Casualties* were but matter of sense, as whether a Childe were *Abortive,* or *Stilborn;* whether men were *Aged,* that is to say, above sixty years old, or thereabouts, when they died, without any curious determination, whether such *Aged* persons died purely of *Age,* as far that the *Innate heat* was quite extinct, or the *Radical moisture* quite dried up (for I have heard some Candid *Physicians* complain of the darkness, which themselves were in hereupon) I say, that these Distinguishments being but matter of sense, I concluded the *Searchers* Report might be sufficient in the Case.

7. As for *Consumptions,* if the *Searchers* do but truly Report (as they may) whether the dead Corps were very lean, and worn away, it matters not to many of our purposes, whether the Disease were exactly the same, as *Physicians* define it in their Books. Moreover, In case a man of seventy five years old died of a *Cough* (of which had he been free, he might have possibly lived to ninety) I esteem it little errour (as to many of our purposes) if this Person be, in the Table of *Casualties,* reckoned among the *Aged,* and not placed under the Title of *Coughs.*

8. In the matter of *Infants* I would desire but to know clearly, what the *Searchers* mean by *Infants,* as whether Children that cannot speak, as the word *Infans* seems to signifie, or Children under two or three years old, although I should not be satisfied, whether the *Infant* died of *Winde,* or of *Teeth,* of the *Convulsion, &c.* or were choak'd with *Phlegm,* or else of *Teeth, Convulsion,* and *Scowring,* apart or together, which they say, do often cause one another: for, I say, it is somewhat, to know how many die usually before they can speak, or how many live past any assigned number of years.

9. I say, it is enough, if we know from the *Searchers* but the most predominant Symptomes; as that one died of the *Head-Ache,* who was sorely tormented with it, though the *Physicians* were of Opinion, that the Disease was in the *Stomach.* Again, if one died *suddenly,* the matter is not great, whether it be reported in the Bills, *Suddenly, Apoplexie,* or *Planet-strucken, &c.*

10. To conclude, In many of these cases the *Searchers* are able to report the Opinion of the *Physician,* who was with the Patient, as they receive the same from the Friends of the Defunct, and in very many cases, such as *Drowning, Scalding, Bleeding, Vomiting, making-away them selves, Lunatiques, Sores, Small-Pox, &c.* their own senses are sufficient, and the generality of the World, are able prettie well to distinguish the *Gowt, Stone, Dropsie, Falling-Sickness, Palsie, Agues, Plurisy, Rickets, &c.* one from another.

11. But now as for those Casualties, which are aptest to be confounded, and mistaken, I shall in the ensuing Discourse presume to touch upon them so far, as the Learning of these Bills hath enabled.

12. Having premised these general Advertisements, our first Observation upon the *Casualties* shall be, that in twenty Years there dying of all diseases and *Casualties,* 229250. that 71124. dyed of the *Thrush, Convulsion, Rickets, Teeth,* and *Worms*; and as *Abortives, Chrysomes, Infants, Liver-grown,* and *Overlaid*; that is to say, that about ⅓ of the whole died of those Diseases, which we guess did all light upon Children under four or five Years old.

13. There died also of the *Small-Pox, Swine-Pox,* and *Measles,* and of *Worms* without *Convulsion,* 12210 of which number we suppose likewise, that about 1/2 might be Children under six Years old. Now, if we consider that 16 of the said 229 thousand died of that extraordinary and grand *Casualty* the *Plague,* we shall finde that about thirty six *per centum* of all quick conceptions, died before six years old.

14. The second Observation is; That of the said 229250 dying of all Diseases, there died of acute Diseases (the *Plague* excepted) but about 50000, or 2/9 parts. The which proportion doth give a measure of the state, and disposition of this *Climate,* and *Air,* as to health, these *acute,* and *Epidemical* Diseases happening suddenly, and vehemently, upon the like corruptions, and alterations in the *Air.*

15. The third Observation is, that of the said 229 thousand about 70 died of *Chronical* Diseases, which shews (as I conceive) the state, and disposition of the Country (including as well its *Food,* as *Air*) in reference to health, or rather to *longaevity*: for as the proportion of the *Acute* and *Epidemical* Diseases shews the aptness of the *Air* to suddain and vehement Impressions, so the *Chronical* Diseases shew the ordinary temper of the Place, so that upon the proportion of *Chronical* Diseases seems to hang the judgment of the fitness of the Country for *long Life.* For, I conceive, that in Countries subject to great *Epidemical* sweeps men may live very long, but where the proportion of the *Chronical* distempers is great, it is not likely to be so; because men being long sick and alwayes sickly, cannot live to any great age, as we see in several sorts of *Metal-men,* who although they are less subject to acute Diseases then others, yet seldome live to be old, that is, not to reach unto those years, which *David* saies is the age of man.

16. The fourth Observation is; That of the said 229250 not 4000 died of outward *Griefs,* as of *Cancers, Fistulaes, Sores, Ulcers, broken and bruised Limbs, Impostumes, Itch, King's-evil, Leprosie, Scald-head, Swine-Pox, Wens, &c. viz.* not one in 60.

17. In the next place, whereas many persons live in great fear, and apprehension of some of the more formidable, and notorious diseases following; I shall onely set down how many died of each: that the respective numbers, being compared with the Total 229250, those persons may the better understand the hazard they are in.

Table of Notorious Diseases		**Table of Casualties**	
Apoplex	1306	*Bleeding*	069
Cut of the Stone	0038	*Burnt, and Scalded*	125
Falling Sickness	0074	*Drowned*	829
Dead in the Streets	0243	*Excessive drinking*	002
Gowt	0134	*Frighted*	022
Head-Ach	0051	*Grief*	279
Jaundice	0998	*Hanged themselves*	222
Lethargy	0067	*Kil'd by several accidents*	1021
Leprosy	0006	*Murthered*	0086
Lunatique	0158	*Poysoned*	014
Overlaid, and Starved	0529	*Smothered*	026
Palsy	0423	*Shot*	007
Rupture	0201	*Starved*	051
Stone and Strangury	0863	*Vomiting*	136
Sciatica	0005		
Sodainly	045		

18. In the foregoing Observations we ventured to make a Standard of the healthfulness of the *Air* from the proportion of *Acute* and *Epidemical* diseases, and of the wholesomeness of the Food from that of the *Chronical.* Yet, forasmuch as neither of them alone do shew the *longaevity* of the Inhabitants, we shall in the next place come to the more absolute Standard, and Correction of both, which is the proportion of the aged, *viz.* 15757 to the Total 229250. That is of about 1 to 15 or 7 *per Cent.* Onely the question is, what number of Years the *Searchers* call *Aged,* which I conceive must be the same, that *David* calls so, *viz.* 70. For no man can be said to die properly of *Age,* who is much less: it follows from hence, that if in any other Country more then seven of the 100 live beyond 70, such Country is to be esteemed more healthfull then this of our City.

19. Before we speak of particular *Casualties,* we shall observe, that among the several *Casualties* some bear a constant proportion unto the whole number of *Burials*; such are *Chronical* diseases, and the diseases, whereunto the City is most subject; as for Example, *Consumptions, Dropsies, Jaundice, Gowt, Stone, Palsie, Scurvy, rising of the Lights,* or *Mother, Rickets, Aged, Agues, Feavers,* *Bloody-Flux,* and *Scowring*: nay some Accidents, as *Grief, Drowning, Men's making away themselves,* and being *Kil'd by several Accidents, &c.* do the like, whereas *Epidemical,* and *Malignant* diseases, as the *Plague, Purples, Spotted-Feaver, Small-Pox,* and *Measles* do not keep that equality, so as in some Years, or Moneths, there died ten times as many as in others.

CHAPTER III
Of Particular Casualties

1. My first Observation is, That few are *starved.* This appears, for that of the 229250 which have died, we find not above fifty one to have been *starved,* excepting helpless *Infants* at Nurse, which being caused rather by carelessness, ignorance, and infirmity of the Milch-women, is not properly an effect, or sign of want of food in the Countrey, or of means to get it.

2. The Observation, which I shall add hereunto, is, That the vast numbers of *Beggars,* swarming up and down this City, do all live, and seem to be most of them healthy and strong; whereupon I make this Question, Whether, since they do all live by Begging, that is, without any kind of labour; it were not better for the State to keep them, even although they earned nothing; that so they might live regularly, and not in that Debauchery, as many Beggars do; and that they might be cured of their bodily Impotencies, or taught to work, *&c.* each according to his condition, and capacity; or by being employed in some work (not better undone) might be accustomed, and fitted for labour.

3. To this some may Object; That *Beggars* are now maintained by voluntary Contributions, whereas in the other way the same must be done by a general Tax; and consequently, the Objects of Charity would be removed, and taken away.

4. To which we Answer; That in *Holland,* although no where fewer Beggars appear to charm up commiseration in the credulous, yet no where is there greater, or more frequent Charity: onely indeed the Magistrate is both the *Beggar,* and the *disposer* of what is gotten by *begging;* so as all Givers have a moral certainty, that their Charity shall be well applied.

5. Moreover, I question; Whether what we give to a Wretch, that shews us lamentable sores, and mutilations, be always out of the purest charity? that is, purely for God's sake; for as much as when we see such Objects, we then feel in our selves a kinde of pain, and passion by consent; of which we ease our selves, when we think we have eased them, with whom we sympathized: or else we bespeak aforehand the like commiseration in others towards our selves, when we shall (as we fear we may) fall into the like distress.

6. We have said, *'Twere better the Publick should keep the Beggars, though they earned nothing, &c.* But most men will laugh to hear us suppose, That any able to work (as indeed most *Beggars* are, in one kind of measure, or another) should be kept without earning anything. But we Answer, That if there be but a certain proportion of work to be done; and that the same be already done by the *not-Beggars*; then to employ the *Beggars* about it, will but transfer the want from one hand to another; nor can a Learner work so cheap as a skilfull practised Artist can. As for example, A practised *Spinner* shall spin a pound of Wool worth two shillings for six pence; but a learner, undertaking it for three pence, shall make the Wool indeed into Yarn, but not worth twelve pence.

7. This little hint is the model of the greatest work in the World, which is the making *England* as considerable for Trade as *Holland*; for there is but a certain proportion of the Trade in the world, and *Holland* is prepossessed of the greater part of it, and is thought to have more skill, and experience to manage it: wherefore, to bring *England* into *Holland's* condition, as to this particular, is the same, as to send all the Beggars about *London* into the *West-Countrey* to Spin, where they shall onely spoil the *Clothiers* Wool, and beggar the present Spinners at best; but, at worst, put the whole Trade of the Countrey to a stand, untill the *Hollander,* being more ready for it, have snapt that with the rest.

8. My next Observation is; That but few are *Murthered, viz.* not above 86 of the 229250, which have died of other diseases, and casualties; whereas in *Paris* few nights scape [*sic*] without their *Tragedie.*

9. The Reasons of this we conceive to be *Two*; One is the *Government,* and *guard* of the City by *Citizens* themselves, and that alternately. No man settling into a Trade for that employment. And the other is, The natural, and customary abhorrence of that inhumane *Crime,* and all *Bloodshed* by most *Englishmen*: for of all that are *Executed* few are for *Murther.* Besides the great and frequent Revolutions, and Changes of *Government* since the year 1650, have been with little *bloodshed*; the *Usurpers* themselves having *Executed* few in comparison, upon the Accompt of the disturbing their Innovations.

10. In brief, when any dead Body is found in *England,* no *Algebraist,* or *Uncipherer* of Letters, can use more subtile suppositions, and varietie of conjectures to finde out the Demonstration, or Cipher; then every common unconcerned Person doth to finde out the Murtherers, and that for ever, untill it be done.

11. The *Lunaticks* are also but few, *viz.* 158 in 229250, though I fear many more then are set down in our *Bills,* few being entred for such, but those who die at *Bedlam*; and there all seem to die of their *Lunacie,* who died *Lunaticks;* for there is much difference in computing the number of

Lunaticks, that die (though of *Fevers,* and all other Diseases, unto which *Lunacie* is no *Supersedeas*) and those, that die by reason of their *Madness*.

12. So that, this *Casualty* being so uncertain, I shall not force my self to make any inference from the numbers, and proportions we finde in our Bills concerning it: onely I dare ensure any man at this present, well in his Wits, for one in the thousand, that he shall not die a *Lunatick* in *Bedlam,* within these seven years, because I finde not above one in about one thousand five hundred have done so.

13. The like use may be made of the Accompts of men, that made away themselves, who are another sort of Madmen, that think to ease themselves of pain by leaping into *Hell*; or else are yet more Mad, so as to think there is no such place; or that men may go to rest by death, though they die in *self-murther,* the greatest Sin.

14. We shall say nothing of the numbers of those, that have been *Crowned, Killed by falls from Scaffolds,* or by *Carts running over them, &c.* because the same depends upon the casual Trade, and Employment of men, and upon matters, which are but circumstantial to the Seasons, and Regions we live in; and affords little of that Science, and Certainty we aim at.

15. We finde one *Casualty* in our Bills, of which though there be daily talk, there is little effect, much like our abhorrence of *Toads,* and *Snakes,* as most poisonous Creatures, whereas few men dare say upon their own knowledge, they ever found harm by either; and this *Casualty* is the *French-Pox,* gotten, for the most part, not so much by the intemperate use of *Venery* (which rather causeth the *Gowt*) as of many common Women.

16. I say, the Bills of *Mortality* would take off these Bars, which keep some men within bounds, as to these extravagancies: for in the afore-mentioned 229250 we finde not above 392 to haved died of the *Pox.* Now, forasmuch as it is not good to let the World be lulled into a security, and belief of Impunity by our Bills, which we intend shall not be onely as *Death's-heads* to put men in minde of their *Mortality,* but also as *Mercurial Statues* to point out the most dangerous ways, that lead us into it, and misery. We shall therefore shew, that the *Pox* is not as the *Toads,* and *Snakes* afore-mentioned, but of a quite contrary nature, together with the reason, why it appears otherwise.

17. Foreasmuch as by the ordinary discourse of the world it seems a great part of men have, at one time or other, had some *species* of this disease, I wondering why so few died of it, especially because I could not take that to be so harmless, whereof so many complained very fiercely; upon inquirey I found that those who died of it out of the Hospitals (especially that of *King's-Land,* and the *Lock* in *Southwark)* were returned of *Ulcers,* and *Sores.* And in brief I found, that all mentioned to die of the *French-Pox* were retured [*sic*] by the *Clerks* of Saint *Giles's,* and Saint *Martin's* *in the Fields* onely; in which place I understood that most of the vilest, and most miserable houses of uncleanness were: from whence I concluded, that onely *hated* persons, and such, whose very *Noses* were eaten of [*sic*] were reported by the *Searchers* to have died of this too frequent *Maladie*.

18. In the next place, it shall be examined under what name, or *Casualties,* such as die of these diseases are brought in: I say, under the *Consumption*: forasmuch, as all dying thereof die so emaciated and lean (their *Ulcers* disappearing upon Death) that the Old-women *Searchers* after the mist of a Cup of *Ale,* and the bribe of a two-groat fee, instead of one, given them, cannot tell whether this emaciation, or leanness were from a *Phthisis,*[38] or from an *Hectick Fever,*[39] *Atrophy, &c.* or from an Infection of the *Spermatick* parts, which in length of time, and in various disguises hath at last vitiated the habit of the Body, and by disabling the parts to digest their nourishment brought them to the condition of Leanness above-mentioned.

19. My next Observation is, that of the *Rickets* we finde no mention among the *Casualties*; untill the year 1634, and then but of 14 for that whole year.

20. Now the Question is, whether that Disease did first appear about that time; or whether a Disease, which had been long before, did then first receive its Name?

21. To clear this Difficulty out of the Bills (for I dare venture on no deeper Arguments:) I enquired what other Casualties before the year 1634, named in the Bills, was most like the *Rickets*; and found, not onely by Pretenders to know it, but also from other Bills, that *Liver-grown* was the nearest. For in some years I finde *Liver-grown, Spleen,* and *Rickets,* put all together, by reson [*sic*] (as I conceive) of their likeness to each other. Hereupon I added the *Liver-growns* of the year 1634, *viz.* 77, to the *Rickets* of the same year, *viz.* 14. making in all 91 which Total, as also the Number 77 it self, I compared with the *Liver-grown* of the precedent year, 1633, *viz.* 82. All which shewed me, that the *Rickets* was a new Disease over and above.

22. Now, this being but a faint Argument, I looked both forwards and backwards, and found, that in the year 1629, when no *Rickets* appeared, there was but 94 *Liver-growns*; and in the year 1636 there was 99 *Liver-grown,* although there were also 50 of the *Rickets*: onely this is not to be denyed, that when the *Rickets* grew very numerous (as in the year 1660, *viz.* to be 521) then there appeared not above 15 of *Liver-grown.*

23. In the year 1659 were 441 *Rickets,* and 8 *Liver-grown.* In the year 1658, were 476 *Rickets,* and 51 *Liver-grown.* Now, though it be granted that these Diseases were confounded in the judgment of the *Nurses,* yet it is most certain, that the *Liver-grown* did never but once, *viz. Anno* 1630, exceed 100 whereas *Anno* 1660, *Liver-grown,* and *Rickets* were 536.

24. It is also to be observed, That the *Rickets* were never more numerous then now, and that they are still increasing; for *Anno* 1649, there was but 190, next year 260, next after that 329, and so forwards, with some little starting backwards in some years, untill the year 1660, which produced the greatest of all.

25. Now, such backstartings seem to be universal in all things; for we do not onely see in the progressive motion of the wheels of *Watches,* and in the rowing of *Boats,* that there is a little starting, or jerking backwards between every step forwards, but also (if I am not much deceived) there appeared the like in the motion of the *Moon,* which in the long *Telescopes* at *Gresham-College* one may sensibly discern.

26. There seems also to be another new Disease, called by our Bills *The stopping of the Stomack,* first mentioned in the year 1636, the which [*sic*] *Malady* from that year to 1647, increased but from 6 to 29; *Anno* 1655 it came to be 145. In 57, to 277. In 60, to 214. Now these proportions far exceeding the difference of proportion generally arising from the increase of Inhabitants, and from the resort of *Advenae* to the City, shews there is some new Disease, which appeareth to the Vulgar as *A stopping of the Stomach.*

27. Hereupon I apprehended, that this *Stopping* might be the *Green-sickness,*[40] for as much as I finde few, or none, to have been returned upon that Accompt, although many be visibly stained with it. Now whether the same be forborn out of shame, I know not? For since the world believes, that Marriage cures it, it may seem indeed a shame, that any maid should die uncured, when there are more *Males* then *Females,* that is, an overplus of Husbands to all that can be Wives.

28. In the next place I conjectured, that this *stopping of the Stomach* might be the *Mother,* for as much as I have heard of many troubled with *Mother-fits* (as they call them) although few returned to have died of them; which conjecture, if it be true, we may then safely say, That the *Mother-fits* have also increased.

29. But I was somewhat taken off from thinking this *stopping of the Stomach* to be the *Mother,* because I guessed rather the *Rising of the Lights* might be it. For I remembered that some Women, troubled with the *Mother-fits,* did complain of a *choaking in their Throats.* Now as I understand, it is more conceivable, that the *Lights,* or *Lungs* (which I have heard called *The Bellows of the Body*) not blowing, that is, neither venting out, nor taking in breath, might rather cause such a *Choaking,* then that the *Mother* should rise up thither, and do it. For me-thinks, when a woman is with childe, there is a greater rising, and yet no such Fits at all.

30. But what I have said of the *Rickets,* and *stopping of the Stomach,* I do in some measure say of the *Rising of the Lights* also, *viz.* that these *Risings* (be they what they will) have increased much above the general proportion; for in 1629 there was but 44, and in 1660, 249, *viz.* almost six times as many.

31. Now for as much as *Rickets* appear much in the *Over-growing* of *Childrens' Livers,* and *Spleens* (as by the Bills may appear) which surely may cause *stopping of the Stomach* by squeezing, and crowding upon that part. And for as much as these *Choakings,* or *Risings of the Lights* may proceed from the same stuffings, as make the *Liver,* and *Spleen* to over-grow their due proportion. And lastly, for as much as the *Rickets, stopping of the Stomach, and rising of the Lights,* have all increased together, and in some kinde of correspondent proportions; it seems to me, that they depend one upon another. And that what is the *Rickets* in children may be the other in more grown bodies; for surely children, which recover of the *Rickets,* may retain somewhat sufficient to cause what I have imagined; but of this let the learned *Physicians* consider, as I presume they have.

32. I had not medled thus far, but that I have heard, the first hints of the circulation of the Blood were taken from a common Person's wondering what became of all the blood which issued out of the heart, since the heart beats above three thousand times an hour, although but one drop should be pumpt out of it, at every stroke.

33. The *Stone* seemed to decrease: for in 1632, 33, 34, 35, and 36. there died of the *Stone,* and *Strangury,* 254. And in the Years 1655, 56, 57, 58, 59, and 1660, but 250, which numbers although in deed they be almost equal, yet considering the Burials of the first named five Years were but half those of the latter, it seems to be decreased by about one half.

34. Now the *Stone,* and *Strangury,* are diseases, which most men know, that feel them, unless it be in some few cases, where (as I have heard *Physicians* say) a *Stone* is held up by the *Filmes* of the *Bladder,* and so kept from grating, or offending it.

35. The *Gowt* stands much at a stay, that is, it answers the general proportion of the Burials; there dies not above one of 1000 of the *Gowt,* although I believe that more die *gowty.* The reason is, because those that have the *Gowt,* are said to be *Long-livers,* and therefore, when such die, they are returned as *Aged*.

36. The *Scurvy* hath likewise increased, and that gradually from 12, *Anno* 1629, to 95, *Anno* 1660.

37. The *Tyssick* seems to be quite worn away, but that it is probable the same is entred as *Cough,* or *Consumption*.

38. *Agues* and *Fevers* are entred *promiscuously,* yet in the few Bills, wherein they have been distinguished, it appears that not above one in 40, of the whole are *Agues*.

39. The *Abortives,* and *Stil-born* are about the twentieth part of those that are *Christned,* and the numbers seem the same thirty Years ago as now, which shews there were more proportion in those Years then now: or else that in those latter Years due Accompts have not been kept of the *Abortives,* as having been *Buried* without notice, and perhaps not in *Church-Yards.*

40. For that there hath been a neglect in the Accompts of the *Christnings* is most certain, because untill the year 1642, we finde the *Burials* but equal with the *Christnings,* or near thereabouts, but in 1648, when the differences in *Religion* had changed the Government, the *Christnings* were but two thirds of the *burials.* And in the year 1659, not half, *viz.* the *burials* were 14720 (of the *Plague* but 36) and the *Christnings* were but 5670, which great disproportion could be from no other Cause, then that above-mentioned, for as much as the same grew as the Confusions, and Changes grew.

41. Moreover, although the Bills give us in *Anno* 1659 but 5670 *Christnings,* yet they give us 421 *Abortives,* and 226 dying in *Child-bed,* whereas in the year 1631, when the *Abortives* were 410, that is, near the number of the year 1659, the *Christnings* were 8288. Wherefore by the proportion of *Abortives Anno* 1659, the *Christnings* should have been about 8500, but if we shall reckon by the women dying in *Child-bed,* of whom a better Accompt is kept then of *Stil-borns,* and *Abortives,* we shall finde *Anno* 1650, there were 226 *Child-beds;* and *Anno* 1631, 112, *viz.* not 1/2. Wherefore I conceive that the true number of the *Christnings Anno* 1659 is above double to the 5690 set down in our Bills; that is about 11500, and then the *Christnings* will come near the same proportion to the *burials,* as hath been observed in former times.

42. In regular Times, when Accompts were well kept, we finde that not above three in 200 died in *Child-bed,* and that the number of *Abortives* was about treble to that of the women dying in *Child-bed,* from whence we may probably collect, that not one woman of an hundred (I might say of two hundred) dies in her Labour; for as much as there be other Causes of a woman's dying within the Moneth, then the hardness of her Labour.

43. If this be true in these Countries, where women hinder the facility of their *Child-bearing* by affected straightning of their Bodies; then certainly in *America,* where the same is not practised, Nature is little more to be taxed as to women, then in *Brutes,* among whom not one in some thousands do die of their deliveries: what I have heard of the *Irish-women* confirms me herein.

44. Before we quite leave this matter, we shall insert the causes, why the Accompt of *Christnings* hath been neglected more then that of *Burials:* one, and the chief whereof was a Religious Opinion against *Baptizing of Infants,* either as unlawfull, or unnecessary. If this were the onely reason, we might by our defects of this kinde, conclude the growth of this Opinion, and pronounce, that not half the People of *England,* between the years 1650, and 1660, were convinced of the need of *Baptizing.*

45. A second Reason was, The scruples, which many Publick *Ministers* would make of the worthiness of Parents to have their Children Baptized, which forced such questioned Parents, who did also not believe the necessity of having their Children Baptized by such scrupulers, to carry their Children unto such other *Ministers,* as having performed the thing, had not the authority or command of the *Register* to enter the names of the Baptized.

46. A third Reason was, That a little Fee was to be paid for *Registrie.*

47. Upon the whole matter it is most certain, that the number of *Heterodox* Believers was very great between the said year, 1650, and 1660, and so peevish were they, as not to have the Births of their Children *Registred,* although thereby the time of their coming Age might be known, in respect of such Inheritances, as might belong unto them; and withall by such *Registring* it would have appeared unto what *Parish* each Childe had belonged, in case any of them should happen to want its relief.

48. Of *Convulsions* there appeared very few, *viz.* but 52 in the year 1629, which 1636 grew to 709, keeping about that stay, till 1659, though sometimes rising to about 1000.

49. It is to be noted, that from 1629 to 1636, when the *Convulsions* were but few, the number of *Chrysoms,* and *Infants* was greater: for in 1629, there was of *Chrysoms,* and *Infants* 2596, and of the *Convulsion* 52, *viz.* of both, 2648. And in 1636 there was of *Infants* 1895, and of the *Convulsions* 709, in both 2604, by which it appears, that this difference is likely to be onely a confusion in the Accompts.

50. Moreover, we finde that for these later years, since 1636, the Total of *Convulsions* and *Chrysoms* added together are much less, *viz.* by about 400 or 500, *per Annum,* then the like Totals from 1626 to 36, which makes me think, that *Teeth* also were thrust in under the Title of *Chrysoms,* and *Infants,* in as much as in the said years, from 1629 to 1639, the number of *Worms,* and *Teeth,* wants by about 400 *per Annum* of what we find in following years.

CHAPTER IV
Of the Plague

1. Before we leave to discourse of the *Casualties,* we shall add something concerning that greatest *Disease,* or *Casualty* of all, The *Plague.*

There have been in *London,* within this Age, four Times of great *Mortality,* that is to say, the years 1592 and 1593, 1603, 1625, and 1636.

There died *Anno* 1592 from *March* to *December*	25886
Whereof of the *Plague*	11503
Anno 1593	17844
Whereof of the *Plague*	10662
Christned in the said year	4021
Anno 1603 within the same space of time were Buried	37294
Whereof of the *Plague*	30561
Anno 1625 within the same space,	51758
Whereof of the *Plague*	35417
Anno 1636 from *April* to *December*	23359
Whereof of the *Plague*	10400

2. Now it is manifest of it self, in which of these years most died; but in which of them was the greatest *Mortality* of all Diseases in general, or of the *Plague* in particular, we discover thus. In the year 1592, and 1636, we finde the proportion of those dying of the *Plague* in the whole to be near alike, that is about 10 to 23, or 11 to 25, or as about two to five.

3. In the year 1625 we finde the *Plague* to bear unto the whole in proportion as 35 to 51, or 7 to 10, that is almost the triplicate of the former proportion, for the *Cube* of 7 being 343 and the *Cube* of 10 being 1000, the said 343 is not 2/5 of 1000.

4. In *Anno* 1603 the proportion of the *Plague* to the whole was as 30 to 37, *viz.* as 4 to 5, which is yet greater then that last of 7 to 20. For if the Year 1625 had been as great a *Plague-Year* as 1603 there must have died not onely 7 to 10, but 8 to 10, which in those great numbers makes a vast difference.

5. We must therefore conclude the Year 1603 to have been the greatest *Plague-Year* of this age.

6. Now to know in which of these 4 was the greatest Mortality at large, we reason thus,

7. From whence it appears, that *Anno* 1636, the Christnings were about 2/5 parts of the Burials. *Anno* 1592, but 1/6, but in the Year 1603 and 1625 not above an eighth, so that the said two Years were the Years of greatest *Mortality.* We said that the year 1603 was the greatest *Plague* year. And now we say, that the same was not a greater year of *Mortality* than

Anno 1592	Buried Christned		26490 4277	or as	6 1
Anno 1603	There died in the whole Year of all Christned		38244 4784	or as	8 1
1 to 8 or 1¼ to 10	*Anno* 1625	Died in the whole Year Christned	54265 6983	or as	8 1
Anno 1636	There died, *ut supra* Christned		23359 9522	or as	5 2

Anno 1625. Now to reconcile these two Positions, we must alledg, that *Anno* 1625 there was errour in the Accompts, or Distinctions of the *Casualties*; that is, more died of the *Plague* than were accompted for under that name. Which Allegation we also prove, thus, *viz.*

8. In the said year 1625 there are said to have died of the *Plague* 35417 and of all other *Diseases* 18848, whereas in the years, both before and after the same, the ordinary number of burials was between 7 and 8000, so that if we add about 11000 (which is the difference between 7 and 18) to our 35 the whole will be 46000 which bears to the whole 54000 as about 4 to 5, thereby rendering the said year 1625 to be as great a *Plague*- year as that of 1603 and no greater, which answers to what we proved before, *viz.* that the *Mortality* of the two Years was equal.

9. From whence we may probably suspect that about 1/4 part more died of the *Plague* then are returned for such; which we further prove by noting, that *Anno* 1636 there died 10400 of the *Plague,* the 1/4 whereof is 2600. Now there are said to have died of all diseases that Year 12959 out of which number deducting 2600 there remains 10359 more then which there died not in several years next before and after the said year 1636.

10. The next Observation we shall offer is, that the *Plague* of 1603 lasted eight Years. In some whereof there died above 4000, in others above 2000, and in but one less then 600: whereas in the Year 1624 next preceding, and in the year 1626 next following the said great *Plague-year* 1625. There died in the former but 11, and in the latter but 134 of the *Plague.* Moreover in the said year 1625 the *Plague* decreased from its utmost number 4461 a week, to below 1000 within six weeks.

11. The *Plague* of 1636 lasted twelve Years, in eight whereof there died 2000 *per annum* one with another, and never under 300. The which shews, that the Contagion of the *Plague* depends more upon the Disposition of the *Air,* then upon the *Effluvia* from the Bodies of Men.

12. Which also we prove by the sudden jumps, which the *Plague* hath made, leaping in one Week from 118 to 927: and back again from 993 to 258: and from thence again the very next Week to 852. The which effects must surely be rather attributed to change of the *Air,* then of the Constitution of Men's bodies, otherwise then as this depends upon that.

13. It may be also noted, that many times other *Pestilential* Diseases, as *Purple-Feavers, Small-Pox, &c.* do forerun the *Plague* a Year, two or three, for in 1622, there died but 8000; in 1623, 11000; in 24, about 12000; till in 1625 there died of all Diseases above 54000.

CHAPTER V
Other Observations upon the Plague, and Casualties

1. The *Decrease,* and *Increase* of People is to be reckoned chiefly by *Christnings,* because few bear children in *London* but *Inhabitants,* though others die there. The Accompts of *Christnings* were well kept, untill differences in *Religion* occasioned some neglect therein, although even these neglects we must confess to have been regular, and proportionable.

2. By the numbers and proportions of *Christnings,* therefore we observe as followeth, *viz.*

First, That (when from *December,* 1602, to *March* following, there was little, or no *Plague*) then the *Christnings* at a *Medium,* were *between* 110, and 130 *per Week,* few Weeks being above the one, or below the other; but when from thence to *July* the *Plague* increased, that then the *Christenings* decreased to under 90.

Secondly, The Question is, Whether *Teeming-women* died, or fled, or miscarried? The later at this time, seems most probable, because even in the said space, between *March,* and *July,* there died not above twenty *per Week* of the *Plague,* which small number could neither cause the death, or flight of so many Women, as to alter the proportion 1/4 part lower.

3. Moreover, we observe from the 21 of *July* to the 21 of *October,* the *Plague* increasing, reduced the *Christnings* to 70 at a *Medium,* diminishing the above proportion, down to 2/5. Now the cause of this must be flying, and death, as well as miscarriages, and Abortions; for there died within that time about 25000, whereof many were certainly *Women with childe,* besides the fright of so many dying within so small a time might drive away so many others, as to cause this effect.

4. From *December* 1624, to the middle of *April* 1625, there died not above 5 a Week of the *Plague* one with another. In this time, the *Christnings* were one with another 180. The which decreased gradually by the 22 of *September* to 75, or from the proportion of 12 to 5, which evidently squares with our former Observation.

5. The next Observation we shall offer, is, The time wherein the City hath been *Re-Peopled* after a great *Plague;* which we affirm to be by the second year. For in 1627, the *Christnings* (which are our Standard in this Case) were 8408, which in 1624 next preceding the *Plague* year 1625 (that had swept away above 54000) were but 8299, and the *Christnings* of 1626 (which were but 6701) mounted in one year to the said 8408.

6. Now the Cause hereof, for as much as it cannot be a supply by Procreations; *Ergo,* it must be by new Affluxes to *London* out of the Countrey.

7. We might fortifie this Assertion by shewing, that before the *Plague*-year, 1603, the *Christnings* were about 6000, which were in that very year reduced to 4789, but crept up the next year 1604, to 5458, re covering their former ordinary proportion in 1605 of 6504, about which proportion it stood till the year 1610.

8. I say, it followeth, that, let the *Mortality* be what it will, the City repairs its loss of Inhabitants within two years, which Observation lessens the Objection made against the value of houses in *London,* as if they were liable to great prejudice through the loss of Inhabitants by the *Plague.*

CHAPTER VI
Of the Sickliness, Healthfulness, and Fruitfulness of Seasons

1. Having spoken of *Casualties,* we come next to compare the sickliness, healthfulness, and fruitfulness of the several Years, and Seasons, one with another. And first, having in the Chapters aforegoing mentioned the several years of *Plague,* we shall next present the several other sickly years; we meaning by a *sickly Year,* such wherein the *Burials* exceed those, both of the precedent, and the subsequent years, and not above 200 dying of the *Plague,* for such we call *Plague-Years;* and this we do, that the World may see, by what spaces, and intervals we may hereafter expect such times again. Now, we may not call that a more sickly year, wherein more die, because such excess of *Burials* may proceed from increase, and access of People to the City onely.

2. Such sickly years were 1618, 20, 23, 24, 1632, 33, 34, 1649, 52, 54, 56, 58, 61, as may be seen by the Tables.

3. In reference to this Observation, we shall present another, namely, That the more sickly the years are, the less fecund, or fruitfull of Children also they be, which will appear, if the number of Children born in the said sickly years be less, then that of the years both next preceding, and the next following; all which, upon view of the Tables, will be found true, except in a very few Cases, where sometimes the precedent, and sometimes the subsequent years vary a little, but never both together. Moreover, for the confirmation of this Truth, we present you the year 1660, where the *Burials* were fewer then in either of the two next precedent years by 2000, and fewer then in the subsequent by above 4000. And withall, the number of *Christnings* in the said year 1660 was far greater then in any of the three years next aforegoing.

4. As to this year 1660, although we could not be thought *Superstitious*, yet is it not to be neglected, that in the said year was the *King's Restauration* to his Empire over these three Nations, as if God Almighty had caused the healthfulness and fruitfulness thereof to repair the *Bloodshed*, and *Calamities* suffered in his absence. I say, this conceit doth abundantly counterpoise the Opinion of those who think great *Plagues* come in with *Kings* [*sic*] reigns, because it hapned so twice, *viz. Anno* 1603, and 1625, whereas as well the year 1648, wherein the present *King* commenced his right to reign, as also the year 1660, wherein he commenced the exercise of the same, were both eminently healthfull, which clears both *Monarchie*, and our present *King's Familie* from what seditious men have surmised against them.

5. The Diseases, which beside the *Plague* make years unhealthfull in this City, are *Spotted Feavers, Small Pox, Dysentery*, called by some *The Plague in the Guts*, and the unhealthfull Season is the *Autumn*.

CHAPTER VII
Of the difference between Burials, and Christnings

1. The next Observation is, That in the said Bills there are far more *Burials*, then *Christnings*. This is plain, depending onely upon *Arithmetical* computation; for, in 40 years, from the year 1603, to the year 1644, *exclusive* of both years, there have been set down (as happening within the same ground, space, or Parishes) although differently numbered, and divided, 363935 *Burials*, and but 330747 *Christnings* within the 97, 16, and 10 out-Parishes, those of *Westminster, Lambeth, Newington, Redriff, Stepney, Hackney*, and *Islington*, not being included.

2. From this single Observation it will follow, That *London* hath decreased in its People, the contrary whereof we see by its daily increase of Buildings upon new Foundations, and by the turning of great Palacious Houses into small Tenements. It is therefore certain, that *London* is supplied with People from out of the Countrey, whereby not onely to repair the overplus difference of *Burials* above-mentioned, but likewise to increase its *Inhabitants* according to the said increase of housing.

3. This supplying of *London* seems to be the reason, why *Winchester, Lincoln,* and several other Cities have decreased in their Buildings, and consequently in their *Inhabitants*. The same may be suspected of many Towns in *Cornwal,* and other places, which probably, when they were first allowed to send *Burgesses* to the *Parliament,* were more populous then now, and bore another proportion to *London* then now; for several of those *Burroughs* send two *Burgesses,* whereas *London* it self sends but four, although it bears the fifteenth part of the charge of the whole Nation in all *Publick* Taxes, and Levies.

4. But, if we consider what I have upon exact enquiry found true, *viz.* That in the Countrie, within ninetie years, there have been 6339 *Christnings,* and but 5280 *Burials,* the increase of *London* will be salved without inferring the decrease of the People in Countrie; and withall, in case all *England* have but fourteen times more People then *London,* it will appear, how the said increase of the Country may increase the People, both of *London,* and it self; for if there be in the 97, 16, 10, and 7 Parishes, usually comprehended within our Bills, but 460000, for those in, and about *London,* there remains 5980000 in the Countrie, the which increasing about 1/7 part in 40 years, as we shall hereafter prove, doth happen in the Countrie, the whole increase of the Countrie will be about 854000 in the said time, out of which number, if but about 250000 be sent up to *London* in the said 40 years, *viz.* about 6000 *per Annum,* the said *Missions* will make good the alterations, which we finde to have been in, and about *London,* between the years 1603 and 1644 above-mentioned. But that 250000 will do the same, I prove thus, *viz.* in the 8 years, from 1603 to 1612, the *Burials* in all the Parishes, and of all Diseases, the *Plague* included, were at a *Medium* 9750 *per Annum*. And between 1635 and 1644 were 18000, the difference whereof is 8250, which is the Total of the increase of the *Burials* in 40 years, that is about 206 *per Annum*. Now, to make the *Burials* increase 206 *per Annum,* there must be added to the City thirty times as many (according to the proportion of 3 dying out of 41 Families) *viz.* 6180 *Advenae,* the which number multiplied again by the 40 years, makes the *Product* 247200, which is less then the 250000 above propounded; so as there remains above 600000 of increase in the Countrie within the said 40 years, either to render it more populous, or send forth into other Colonies, or Wars. But that *England* hath fourteen times more People, is not improbable, for the Reasons following.

1. *London* is observed to bear about the fifteenth proportion of the whole Tax.
2. There is in *England,* and *Wales,* about 39000 square Miles of Land, and we have computed that in one of the greatest Parishes in *Hampshire,* being also a Market-Town, and containing twelve square Miles, there are

220 souls in every square Mile, out of which I abate 1/4 for the overplus of People more in that parish, then in other wilde Counties. So as the 3/4 parts of the said 220, multiplied by the Total of square Miles, produces 6400000 souls in all *London* included.

3. There are about 100000 parishes in *England,* and *Wales,* the which, although they should not contain the 1/3 part of the Land, nor the 1/4 of the People of that Country-Parish, which we have examined, yet may be supposed to contain about 600 People, one with another, according to which Accompt there will be six Millions of People in the nation. I might add, that there are in *England,* and *Wales,* about five and twenty Millions of Acres at 16 1/2 Foot to the Perch; and if there be six Millions of People, then there is about four Acres for every head, which how well it agrees to the Rules of Plantation, I leave unto others, not onely as a means to examine my Assertion, but as an hint to their enquiry concerning the fundamental Trade, which is Husbandrie, and Plantation.
4. Upon the whole matter we may therefore conclude, That the People of the whole Nation do increase, and consequently the decrease of *Winchester, Lincoln,* and other like places, must be attributed to other Reasons, then that of refurnishing *London* onely.

5. We come to shew, why although in the Country the *Christnings* exceed the *Burials,* yet in *London* they do not. The general Reason of this must be, that in *London* the proportion of those subject to die unto those capable of breeding is greater than in the Country; That is, let there be an hundred Persons in *London,* and as many in the Country; we say, that if there be 60 of them Breeders in *London,* there are more then 60 in the Country, or else we must say, that *London* is more unhealthfull, or that it enclines men and women more to Barrenness, then the Country, which by comparing the Burials, and Christnings of *Hackney, Newington,* and other Country-Parishes, with the most *Smoaky,* and *Stinking* parts of the City, is scarce discernable in any considerable degree.

6. Now that the Breeders in *London* are proportionally fewer then those in the Country arises from these reasons, *viz.*

1. All that have business to the Court of the King, or to the Courts of Justice, and all Country-men coming up to bring Provisions to the City, or to buy Foreign Commodities, Manufactures, and Rarities, do for the most part leave their Wives in the Country.
2. Persons coming to live in *London* out of curiosity, and pleasure, as also such as would retire, and live privately, do the same, if they have any.
3. Such, as come up to be cured of Diseases, do scarce use their Wives *pro tempore.*

4. That many Apprentices of *London,* who are bound seven, or nine years from Marriage, do often stay longer voluntarily.
5. That many Sea-men of *London* leave their Wives behind them, who are more subject to die in the absence of their Husbands, then to breed either without men, or with the use of many promiscuously.
6. As for unhealthiness it may well be supposed, that although seasoned Bodies may, and do live near as long in *London,* as elsewhere, yet new-comers, and Children do not, for the *Smoaks, Stinks,* and close *Air* are less healthfull than that of the Country; otherwise why do sickly Persons remove into the Country *Air?* And why are there more old men in Countries then in *London, per rata*? And although the difference in *Hackney,* and *Newington,* above-mentioned, be not very notorious, yet the reason may be their vicinity to *London,* and that the Inhabitants are most such, whose bodies have first been impaired with the *London air,* before they withdraw thither.

7. As to the causes of Barrenness in *London,* I say, that although there should be none extraordinary in the Native *Air* of the place, yet the intemperance in feeding, and especially the Adulteries and Fornications, supposed more frequent in *London* then elsewhere, do certainly hinder breeding. For a Woman, admitting 10 Men, is so far from having ten times as many Children, that she hath none at all.

8. Add to this, that the minds of men in *London* are more thoughtfull and full of business then in the Country, where their work is *corporal* Labour, and Exercizes. All which promote Breedings, whereas *Anxieties* of the minde hinder it.

CHAPTER VIII
Of the difference between the numbers of Males, and Females

1. The next Observation is, That there be more *Males* then *Females.* There have been Buried from the year 1628, to the year 1662, *exclusive,* 209436 *Males,* and but 190474 *Females*: but it will be objected, that in *London* it may indeed be so, though otherwise elsewhere; because *London* is the great Stage and Shop of business, wherein the *Masculine Sex* bears the greatest part. But we Answer, That there have been also *Christned* within the same time, 139782 *Males,* and but 130866 *Females,* and that the Country Accompts are consonant enough to those of *London* upon this matter.

2. What the Causes hereof are, we shall not trouble our selves to conjecture, as in other Cases, onely we shall desire, that Travellers would enquire whether it be the same in other Countries.

3. We should have given an Accompt, how in every Age these proportions change here, but that we have Bills of distinction but for 32 years, so that we shall pass from hence to some inferences from this Conclusion; as first,

I. That *Christian Religion,* prohibiting *Polygamy,* is more agreeable to the *Law of Nature,* that is the *Law of God,* then *Mahumetism,* and others, that allow it; for one man his having many women, or wives by Law, signifies nothing, unless there were many women to one man in nature also.

II. The obvious Objection hereunto is, That one *Horse, Bull,* or *Ram,* having each of them many *Females,* do promote increase. To which I Answer, That although perhaps there be naturally, even of these *species,* more *Males* then *Females,* yet *artificially,* that is, by making *Geldings, Oxen,* and *Weathers,* there are fewer. From whence it will follow, That when by experience it is found how many *Ews* (suppose twenty) one *Ram* will serve, we may know what proportion of *male-Lambs* to castrate, or geld, *viz.* nineteen, or thereabouts: for if you emasculate fewer, *viz.* but ten, you shall by promiscuous copulation of each of those ten with two *Females,* (in such as admit the *Male* after conception) hinder the increase so far, as the admittance of two *Males* will do it: but, if you castrate none at all, it is highly probable, that every of the twenty *Males* copulating with every of the twenty *Females,* there will be little, or no conception in any of them all.

III. And this I take to be truest Reason, why *Foxes, Wolves,* and other *Vermin Animals* that are not gelt, increase not faster then *Sheep,* when as so many thousands of these are daily Butchered, and very few of the other die otherwise then of themselves.

4. We have hitherto said there are more *Males,* then *Females;* we say next, That the one exceed the other by about a thirteenth part; so that although more men die violent deaths then women, that is, more are *slain* in Wars, *killed* by mischance, *drowned at Sea,* and die by the *Hand of Justice.* Moreover, more men go to *Colonies,* and travel into foreign parts, then women. And lastly, more remain unmarried, then of women, as *Fellows of Colleges,* and *Apprentises,* above eighteen, *&c.* yet the said thirteenth part difference bringeth the business but to such a pass, that every woman may have an Husband, without the allowance of *Polygamy.*

5. Moreover, although a man be *Proflique* fourty years, and a woman but five and twenty, which makes the *males* to be as 560 to 325 *Females,* yet the causes above named, and the later marriage of the men, reduce all to an equality.

6. It appearing, that there were fourteen men to thirteen women, and that they die in the same proportion also, yet I have heard *Physicians* say, that they have two women Patients to one man, which Assertion seems very likely; for that women have either the *Green-sickness,* or other like Distempers, are sick of *Breedings, Abortions, Child-bearing, Sore-breasts, Whites, Obstructions, Fits of the Mother,* and the like.

7. Now, from this it should follow, that more women should die then men, if the number of *Burials* answered in proportion to that of Sicknesses: but this must be salved, either by the alledging, that the *Physicians* cure those Sicknesses, so as few more die, then if none were sick; or else that men, being more intemperate then women, die as much by reason of their Vices, as the women do by the Infirmitie of their *Sex,* and consequently, more *Males* being born, then *Females,* more also die.

8. In the year 1642 many *Males* went out of *London* into the Wars then beginning, in so much, as I expected in the succeeding year, 1643, to have found the *Burials* of *Females* to have exceeded those of *Males,* but no alteration appeared; for as much, as I suppose, Trading continuing the same in *London,* all those who lost their *Apprentices* had others out of the Countrey; and if any left their Trades, or Shops, that others forthwith succeeded them: for if employment for hands remain the same, no doubt but the number of them could not long continue in disproportion.

9. Another pregnant Argument to the same purpose (which hath already been touched on) is, That although in the very year of the *Plague,* the *Christnings* decreased, by the dying and flying of *Teeming- women,* yet the very next year after, they increased somewhat, but the second after, to as full a number as in the second year before the said *Plague:* for I say again, if there be encouragement for an hundred in *London,* that is a Way how an hundred may live better then in the Countrey, and if there be void housing there to receive them, the evacuating of a 1/4th, or 1/3 part of that number, must soon be supplied out of the Countrey; so as, the great *Plague* doth not lessen the Inhabitants of the City, but of the Countrey, who in a short time remove themselves from hence thither, so long, untill the City for want of receit and encouragement, regurgitates and sends them back.

10. From the difference between *Males* and *Females,* we see the reason of making *Eunuchs* in those places where *Polygamy* is allowed, the latter being useless as to multiplication, without the former, as was said before in the case of *Sheep* and other *Animals,* usually gelt in these Countries.

11. By consequence, this practise of *Castracon* serves as well to promote increase as to meliorate the Flesh of those Beasts that suffer it. For that Operation is equally practised upon *Horses* which are not used for Food, as upon those that are.

12. In *Popish* Countries where *Polygamy* is forbidden, if a greater number of *Males* oblige themselves to *Caelibate* then the natural overplus or difference between them and *Females* amounts unto; then multiplication is hindred; for if there be eight Men to ten women, all of which eight men are married to eight of the ten Women, then the other two bear no Children, as either admitting no Man at all, or else admitting Men as Whores (that is more then one) which commonly procreates no more then if none at all had been used: or else such unlawfull Copulations beget Conceptions but to frustrate them by procured Abortions or secret Murthers, all which returns to the same reckoning. Now, if the same proportion of women oblige themselves to a single life likewise, then such obligation makes no change in the matter of encrease.

13. From what hath been said, appears the reason why the Law is, and ought to be so strict against Fornications and Adulteries, for if there were universal liberty, the Increase of Mankind would be but like that of *Foxes* at best.

14. Now forasmuch as Princes are not only Powerfull but Rich, according to the number of their People (Hands being the Father, as Lands are the Mother, and Womb of Wealth) it is no wonder why states by encouraging Marriage, and hindering Licentiousness, advance their own Interest, as well as preserve the Laws of God from contempt, and Violation.

15. It is a Blessing to Man-kind, that by this overplus of *Males* there is this natural Bar to *Polygamy*: for in such a state Women could not live in that parity, and equality of expence with their Husbands, as now, and here they do.

16. The reason whereof is, not, that the Husband cannot maintain as splendidly three, as one; for he might, having three Wives, live himself upon a quarter of his Income, that is in a parity with all three, as-well as, having but one, live in the same parity at half with her alone: but rather, because that to keep them all quiet with each other, and himself, he must keep them all in great aw, and less splendor, which power he having will probably use it to keep them all as low, as he pleases, and at no more cost then makes for his own pleasure; the poorest Subjects (such as this plurality of Wives must be) being the most easily governed.

CHAPTER IX
Of the growth of the City

1. In the year 1593 there died in the ninety seven Parishes within the walls, and the sixteen without the walls (besides 421 of the *Plague)* 3508. And the next year 3478, besides 29 of the *Plague:* in both years 6986. Twenty years after, there died in the same ninety seven, and sixteen Parishes, 12110, *viz. Anno* 1614, 5873; and *Anno* 1615, 6237: so as the said Parishes are increased, in the said time, from seven to twelve, or very near therebouts.

2. Moreover, the *burials* within the like space of the next twenty years, *viz. Anno* 1634, and 1635, were 15625, *viz.* as about twenty four to thirty one: the which last of the three numbers, 15625, is much more than double to the first 6986, *viz.* the said Parishes have in fourty years increased from twenty three to fifty two.

3. Where is to be noted, That although we were necessitated to compound the said ninety seven with the sixteen Parishes, yet the sixteen Parishes have increased faster then the ninety seven. For, in the year 1620, there died within the walls 2726, and in 1660 there died but 3098 (both years being clear of the *Plague)* so as in this fourty years the said ninety seven Parishes have increased but from nine to ten, or thereabouts, because the housing of the said ninety seven Parishes could be no otherwise increased, then by turning great Houses into Tenements, and building upon a few Gardens.

4. In the year 1604, there died in the ninety seven Parishes 1518, and of the *Plague* 260. And in the year 1660, 3098, and none of the *Plague,* so as in fifty six years the said Parishes have doubled: Where note, that forasmuch as the said year 1604 was the very next year after the great *Plague,* 1603 (when the City was not yet re-peopled) we shall rather make the comparison between 2014, which died *Anno* 1605, and 3431 *Anno* 1659, choosing rather from hence to assert, that the said ninety seven, and sixteen Parishes encreased from twenty to thirty four, or from ten to seventeen in fifty four years, then from one to two in fifty six, as in the last aforegoing *Paragraph* is set down.

5. *Anno* 1605, there died in the sixteen out-Parishes 2974, and *Anno* 1659, 6988, so as in the fifty four years, the said Parishes have encreased from three to seven.

6. *Anno* 1605 there died in the eight out-parishes, 960, *Anno* 1659, there died in the same scope of Ground, although called now ten Parishes (the *Savoy,* and *Covent-Garden* being added) 4301, so as the said Parishes have encreased within the said fifty four years, more then from one to four.

7. Moreover, there was buried in all, *Anno* 1605, 5948, and *Anno* 1659 14720, *viz.* about two to five.

8. Having set down the proportions, wherein we find the said three great Divisions of the whole Pyle, call'd *London,* to have encreased; we come next to shew what particular Parishes have had the most remarkable share in these Augmentations, *viz.* of the ninty seven Parishes within the Walls the Increase is not very discernable, but where great houses formerly belonging to Noblemen before they built others neer *White-hall,* have been turned into Tenements, upon which Accompt *Alhallows on the wall* is encreased, by the conversion of the Marquess of *Winchesters* house, lately the *Spanish* Ambassadors, into a New street, the like of Alderman *Freeman,* and *La Motte* neer the *Exchange,* the like of the Earl of *Arundells* in *Loathbury,* the like of the Bishop of *London's* Palace, the Dean of *Paul's,* and the Lord *River's* house, now in hand, as also of the *Dukes-Place,* and others heretofore.

9. Of the sixteen Parishes next without the Walls, Saint *Gile's Criplegate* hath been most inlarged, next to that, Saint *Olave's Southwark,* then Saint *Andrews Holborn,* then *White-Chappel,* the difference in the rest not being considerable.

10. Of the out Parishes now called ten, formerly nine, and before that eight, Saint *Gile's,* and Saint *Martins in the fields,* are most encreased, notwith standing Saint *Pauls Covent-Garden* was taken out of them both.

11. The general observation which arises from hence is, That the City of *London* gradually removes *Westward,* and did not the *Royal exchange,* and *London-Bridg* stay the Trade, it would remove much faster, for *Leaden-Hall-street, Bishops-gate,* and part of *Fan-church-street,* have lost their ancient Trade, *Grace-Church-street* indeed keeping it self yet entire, by reason of its conjunction with, and relation to *London-Bridg.*

12. Again, *Canning-street,* and *Watlin-street* have lost their Trade of *Woolen-Drapery* to *Paul's Church-yard, Ludgate-hill,* and *Fleet-street*; the *Mercery* is gone from out of *Lombard-street,* and *Cheapside,* into *Pater-Noster-Row,* and *Fleet-street.*

13. The reasons whereof are, that the King's Court (in old times frequently kept in the City) is now always at *Westminster.* Secondly, the use of Coaches, whereunto the narrow streets of the old City are unfit, hath caused the building of those broader streets in *Covent-Garden, &c.*

14. Thirdly, where the *Consumption* of Commodity is, *viz.* among the Gentry, the vendors of the same must seat themselves.

15. Fourthly, the cramming up of the voyd spaces, and gardens within the Walls, with houses, to the prejudice of *Light,* and *Air,* have made men Build new ones, where they less fear those inconveniences.

16. Conformity in Building to other civil Nations hath disposed us to let our old Wooden dark houses fall to decay, and to build new ones, whereby to answer all the ends above-mentioned.

17. Where note, that when *Lud-gate* was the onely *Western* Gate of the city, little Building was *Westward* thereof. But when *Holborn* began to encrease *New-gate* was made. But now both these Gates are not sufficient for the Communication between the Walled City, and its enlarged *Western* Suburbs, as dayly appears by the intolerable stops and embaresses of Coaches near both these Gates, especially *Lud-gate.*

CHAPTER X
Of the Inequality of Parishes

1. Before we pass from hence, we shall offer to consideration the inequality of Parishes in, and about *London,* evident in the proportion of their respective *Burials;* for in the same year were buried in *Cripple-gate-Parish* 1191, that but twelve died in *Trinity-Minories,* St. *Saviour's Southwark,* and *Botolph's Bishop-gate,* being of the middle size, as burying five and 600 *per Annum;* so that *Cripple-gate* is an hundred times as big as the *Minories,* and 200 times as big as St. *John the Euangelist's, Mary-Cole-church, Bennet's Grace-church, Matthew-Friday-street,* and some others within the City,

2. Hence may arise this Question, Wherefore should this inequality be continued? If it be Answered, Because that *Pastours* of all sorts, and sizes of Abilities, may have benefices, each man according to his merit: we Answer, That a two hundredth part of the best *parson's* learning is scarce enough for a *Sexton.* But besides, there seems no reason of any differences at all, it being as much Science to save one single soul, as one thousand.

3. We encline therefore to think the Parishes should be equal, or near, because, in the *Reformed Religions,* the principal use of *Churches* is to Preach in: now the bigness of such a *Church* ought to be no greater, then that, unto which the voice of a *Preacher* of middling Lungs will easily extend; I say, easily, because they speak an hour, or more together.

4. The use of such large *Churches,* as *Paul's,* is now wholly lost, we having no need of saying perhaps fifty *Masses* all at one time, nor of making those grand *Processions* frequent in the *Romish church*; nor is the shape of our *Cathedral* proper at all for our *Preaching auditories,* but rather the Figure of an *Amphi-Theatre* with Galleries, gradually over-looking each other; for unto this Condition the Parish-Churches of *London* are driving apace, as appears by the many Galleries every day built in them.

5. Moreover, if Parishes were brought to the size of *Colman-street, Alhallows-Barking, Christ-Church, Black-Friers, &c.* in each whereof die between 100 and 150, *per Annum,* then an hundred Parishes would be a fit, and equal Division of this great charge, and all the *Ministers* (some whereof have now scarce fourty pounds *per Annum*) might obtain a subsistence.

6. And lastly, The *Church-Wardens,* and *Over-seers* of the *Poor* might finde it possible to discharge their Duties, whereas now in the greater out-Parishes many of the poorer Parishioners through neglect do perish, and many vicious persons get liberty to live as they please, for want of some heedfull Eye to overlook them.

CHAPTER XI
Of the number of Inhabitants

1. There have been several times in company with men of great experience in this City, and have heard them talk seldom under Millions of *People* to be in *London,* all which I was apt enough to believe, untill, on a certain day, one of eminent Reputation was upon occasion asserting, that there was in the year 1661 two Millions of People more then *Anno* 1625, before the great *Plague;* I must confess, that, until this provocation, I had been frighted with that misunderstood example of David, from attempting any computation of the People of this populace place; but hereupon I both examined the lawfulness of making such enquiries, and, being satisfied thereof, went about the work itself in this manner: *viz.*

2. First, I imagined, That, if the Conjecture of the worthy Person aforementioned had any truth in it, there must needs be about six, or seven Million of People in *London* now; but repairing to my Bills I found, that not above 15000 *per Annum* were buried, and consequently, that not above one in four hundred must die *per Annum,* if the Total were but six Millions.

3. Next considering, That it is esteemed an even Lay, whether any man lives ten years longer, I supposed it was the same, that one of any 10 might die within one year. But when I considered, that of the 15000 afore-mentioned about 5000 were *Abortive,* and *Stil-born,* or died of *Teeth, Convulsion, Rickets,* or as *Infants,* and *Chrysoms,* and *Aged.* [*sic*] I concluded, that of men, and women, between ten and sixty, there scarce died 10000 *per Annum* in *London,* which number being multiplied by 10, there must be but 100000 in all, that is not the 1/60 part of what the *Alderman* imagined. These were but sudden thoughts on both sides, and both far from truth, I thereupon endeavoured to get a little nearer, thus: *viz.*

4. I considered, that the number of *Child-bearing women* might be about double to the *Births*: forasmuch as such women, one with another, have scarce more then one Childe in two years. The number of *Births* I found, by those years, wherein the *Registries* were well kept, to have been somewhat less then the *Burials.* The *Burials* in these late years at a *Medium* are about 13000, and consequently the *Christnings* not above 12000. I therefore esteemed the number of *Teeming women* to be 24000: then I imagined, that there might be twice as many Families, as of such women; for that there might be twice as many women *Aged* between 16 and 76, as between 16 and 40, or between 20 and 44; and that there were about eight Persons in a Family, one with another, *viz.* the Man, and his Wife, three Children, and three Servants, or Lodgers: now 8 times 48000 makes 384000.

5. Secondly, I finde by telling the number of Families in some Parishes within the walls, that 3 out of 11 families *per an.* Have died: wherefore, 13000 having died in the whole, it should follow, there were 48000 Families according to the last mentioned Accompt.

6. Thirdly, the Accompt, which I made of the *Trayned-Bands,* and *auxiliary* Souldiers, doth enough justify this Accompt.

7. And lastly I took the Map of *London* set out in the year 1658 by *Richard Newcourt,* drawn by a scale of Yards. Now I guessed that in 100 yards square there might be about 54 Families, supposing every house to be 20 foot in the front: for on two sides of the said square there will be 100 yards of housing in each, and in the two other sides 80 each; in all 360 yards: that is 54 Families in each square, of which there are 220 within the Walls, making in all 11880 Families within the Walls. But forasmuch as there dy within the Walls about 3200 *per Annum,* and in the whole about 13000; it follows, that the housing within the Walls is 1/4 part of the whole, and consequently, that there are 47520 Families in, and about *London,* which agrees well enough with all my former computations: the worst whereof doth sufficiently demonstrate, that there are no Millions of People in *London,* which nevertheless most men do believe, as they do, that there be three Women for one Man, whereas there are fourteen Men for thirteen Women, as else where hath been said.

8. We have (though perhaps too much at Random) determined the number of the inhabitants of *London* to be about 384000: the which being granted, we assert, that 199112 are *Males,* and 184886 *Females.*

9. Where as we have found, that of 100 quick Conceptions about 36 of them die before they be six years old, and that perhaps but one surviveth 76, we, having seven *Decads* between six and 76, we sought six mean proportional numbers between 64, the remainer, living at six years, and the one, which survives 76, and finde, that the numbers following are practically near enough to the truth; for men do not die in exact Proportions, nor in Fractions: from when arises this Table following.

Viz. of 100 there dies		The fourth	6
within the first six years	36	The next	4
The next ten years, or *Decad*	24	The next	3
The second *Decad*	15	The next	2
The third *Decad*	09	The next	1

10. From whence it follows, that of the said 100 conceived there remains alive at six years end 64.

At Sixteen years end	40	At Fifty six	6
At Twenty six	25	At Sixty six	3
At Thirty six	16	At Seventy six	1
At Fourty six	10	At Eighty	0

11. It follows also, that of all, which have been conceived, there are now alive 40 *per Cent.* Above sixteen years old, 25 above twenty six years old, *&* *sic deinceps,* as in the above Table: there are therefore of Aged between 16, and 56, the number of 40, less by six, *viz.* 34; of between 26, and 66, the number of 25 less by three, *viz.* 22: *sic deniceps.* Wherefore, supposing there be 199112 *Males,* and the number between 16, and 56, being 34. It follows, there are 34 *per Cent.* Of all those *Males* fighting Men in *London,* that is 67694, *viz.* near 70000: the truth whereof I leave to examination, only the 1/5 of 67694, *viz.* 13539 is to be added for *Westminster, Stepney, Lambeth,* and the other distant Parishes, making in all 81233 fighting Men.

12. The next enquiry shall be, In how long time the City of *London* shall, by the ordinary proportion of Breeding, and Dying, double its breeding People. I answer in about seven years, and (*Plagues* considered) eight. Wherefore since there be 24000 pair of Breeders, that is 1/8 of the whole, it follows, that in eight times eight years the whole People of the City shall double without the access of Foreigners: the which contradicts not our Accompt of its growing from two to five in 56 years with such accesses.

13. According to the this [*sic*] proportion, one couple *viz. Adam* and *Eve,* doubling themselves every 64 years of the 5610 years, which is the *age* of the World according to the *Scriptures,* shall produce far more People, than are now in it. Wherefore the World is not above 100 thousand years, old as some vainly Imagine, nor above what the *Scripture* makes it.

CHAPTER XII
Of the Country Bills

We have, for the present, done with our Observations upon the Accompts of *Burials,* and *Christnings,* in, and about *London;* we shall next present the Accompts of both *Burials, Christnings,* and also of *Weddings* in the Country, having to that purpose inserted Tables of 90 years for a certain Parish in *Hampshire,* being a place neither famous for *Longevity,* and *Healthfulness,* nor for the contrary. Upon which Tables we observe,

1. That every *Wedding,* one with another, produces four Children, and consequently, that that is the proportion of Children, which any Marriagable man, or woman may be presumed shall have. For, though a man may be Married more then once, yet, being once Married, he may die without any Issue at all.

2. That in this Parish there were born 15 *Females* for 16 *Males,* whereas in *London,* there were 13 for 14, which shews, that *London* is somewhat more apt to produce *Males,* then the country. And it is possible, that in some other places there are more *Females* born, then *males,* which, upon this variation of proportion, I again recommend to the examination of the curious.

3. That in the said whole 90 years the *Burials* of the *Males* and *Females* were exactly equal, and that in several *Decads* they differed not 1/100 part, that in one of the two *Decads,* wherein the difference was very notorious, there were Buried of *Males* 337, and of *Females* but 284, *viz.* 53 difference, and in the other there died contrariwise 338 *Males,* and 386 *Females,* differing 46.

4. There are also *Decads,* where the Birth of *Males* and *Females* differ very much, *viz.* about 60.

5. That in the said 90 years there have been born more, then buried in the said Parish, (the which both 90 years ago, and also now, consisted of about 2700 Souls) but 1059, *viz.* not 12 *per Annum,* one year with another.

6. That these 1059 have in all probability contributed to the increase of *London;* since, as was said even now, it neither appears by the *Burials, Christnings,* or by the built of new-housing, that the said Parish is more populous now, then 90 years ago, by above two or 300 souls. Now, if all other places send about 1/3 of their encrease, *viz.* about one out of 900 of their Inhabitants *Annually* to *London,* and that there be 14 times as many people in *England,* as there be in *London,* (for which we have given some reasons) then *London* encreases by such *Advenae* every year above 6000; the which will make the Accompt of *Burials* to swell about 200 *per Annum,* and will answer the encreases. We observe it is clear, that the said Parish is encreased about 300, and it is probable, that three or four hundred more went to *London,* and it is known, That about 400 went to *New-England,* the *Caribe-Islands,* and *New-found-Land,* within these last fourty years.

7. According to the *Medium* of the said whole 90 years, there have been five *Christnings* for four *Burials,* although in some single *Years,* and *Decads,* there have been three to two, although sometimes (though more rarely) the *Burials* have exceeded the *Births,* as in the case of *Epidemical Diseases.*

8. Our former Observation, That healthfull years are also the most fruitfull, is much confirmed by our Country Accompts; for, 70 being our Standard for *Births,* and 58 for *Burials,* you shall finde, that where fewer then 58 died, more then 70 were born. Having given you a few instances thereof, I shall remit you to the Tables for the general proof of this Assertion. *Viz. Anno* 1633, when 103 were born, there died but 29. Now, in none of the whole 90 years more were born then 103, and but in one, fewer then 29 died, *viz.* 28 *Anno* 1658. Again *Anno* 1568, when 93 were born, but 42 died. *Anno* 1584, when 90 were born, but 41 died. *Anno* 1650, when 86 were born, but 52 died. So that by how much more are born, by as much (as it were) the fewer die. For when 103 were born, but 29 died: but when but 86 were born, then 52 died.

On the other side *Anno* 1638, when 156 died *per Annum,* which was the greatest year of *Mortality,* then less then the meer Standard 70, *viz.* but 66 were born. Again *Anno* 1644, when 137 died, but 59 were born. *Anno* 1597, when 117 died, but 48 were born. And *Anno* 1583, when 87 died, but 59 were born.

A little Irregularity may be found herein, as that *Anno* 1612, when 116 died (*viz.* a number double to our Standard 58 yet) 87 (*viz.* 17 about the Standard 70) were born. And that when 89 died 075 [*sic*] were born: but these differences are not so great, nor so often, as to evert our Rule, which besides the Authority of these Accompts is probable in it self.

9. Of all the said 90 years the year 1638 was the most *Mortal,* I therefore enquired whether the *Plague* was then in that parish, and having received good satisfaction that it was not (which I the rather believe, because, that the *Plague* was not then considerable at *London*) but that it was a Malignant *Fever* raging so fiercely about *Harvest,* that there appeared scarce hands enough to take in the Corn: which argues, considering there were 2700 Parishioners, that seven might be sick for one that died: whereas of the *Plague* more die then recover. Lastly, these People lay longer sick then

Decad	**Greatest**	**Least**
	Number of Burials	
1	66	34
2	87	39
3	117	38
4	53	30
5	116	51
6	89	50
7	156	35
8	137	46
9	80	28

is usual in the *Plague,* nor was there any mention of *Sores, Swellings, blew-Tokens, &c.* among them. It follows, that the proportion between the *greatest* and the *least Mortalities* in the Country are far greater then at *London.* Forasmuch as the greatest 156 is above *quintuple* unto 28 the least, whereas in *London* (the *Plague* excepted, as here it hath been) the number of Burials upon other Accompts within no *Decad* of years hath been double, whereas in the Country it hath been *quintuple* not onely within the whole 90 years, but also within the same *Decad:* for *Anno* 1633, there died but 29, and *Anno* 1638 the above-mentioned number of 156. Moreover, as in *London,* in no *Decad,* the Burials of one year are double to those of another: so in the Country they are seldom not more then so. As by this Table appears, [See table on previous page. Ed.]

Which shews, that the opener, and freer *Airs* are most subject both to the good and bad Impressions, and that the *Fumes, Steams,* and *Stenches* of *London* do so medicate, and impregnate the *Air* about it, that it becomes capable of little more, as if the said *Fumes* rising out of *London* met with, opposed, and justled backwards the Influences falling from above, or resisted the Incursion of the Country-*Airs.*

10. In the last *Paragraph* we said, that the Burials in the Country were sometimes *quintuple* to one another, but of the Christnings we affirm, that within the same *Decad* they are seldome double, as appears by this Table, *viz.*

Now, although the disproportions of Births be not so great as that of *Burials,* yet these disproportions are far greater then at *London;* for let it be shewn in any of the *London* Bills, that within two years the *Christnings* have decreased 1/2 or increased double, as they did *Anno* 1584, when 90 were born, and *An.* 1586, wherein were but 45: or to rise from 52, as *Anno*

	Greatest	**Least**
Decad	**Number of Burials**	
1	70	50
2	90	45
3	71	52
4	93	60
5	87	61
6	85	63
7	103	66
8	87	62
9	86	52

1593, to 71, as in the next year 1594. Now, those disproportions both in births, and Burials, confirm what hath been before Asserted, that *Healthfulness,* and *Fruitfulness* go together, as they would not, were there not disproportions in both, although proportional.

11. By the Standard of Burials in this parish, I thought to have computed the number of Inhabitants in it, *viz.* by multiplying 58 by 4, which made the *Product* 232, the number of Families. Hereupon I wondered, that a Parish containing a large Market-Town, and 12 Miles compass, should have but 232 Houses, I then multiplied 232 by 8, the *Product* whereof was 1856, thereby hoping to have had the number of the Inhabitants, as I had for *London;* but when upon enquiry I found there had been 2100 Communicants in that parish in the time of a *Minister,* who forced too many into that Ordinance, and that 1500 was the ordinary number of Communicants at all times, I found also, that for as much as there were near as many under 16 years old, as there are above, *viz.* Communicants, I concluded, that there must be about 27, or 2800 Souls in that parish: from whence it follows, that little more then one of 50 dies in the Country, whereas in *London,* it seems manifest, that about one in 32 dies, over and above what dies of the *Plague.*

12. It follows therefore from hence, what I more faintly asserted in the former Chapter, that the Country is more *healthfull,* then the City, That is to say, although men die more regularly, and less *per Saltum* in *London,* then in the Country, yet upon the whole matter, there die fewer *per Rata*; so as the Fumes, Steams, and Stenches above-mentioned, although they make the Air of *London* more equal, yet not more *Healthfull.*

13. When I consider, That in the Country seventy are Born for fifty eight Buried, and that before the year 1600 the like happened in *London,* I considered whether a City, as it becomes more populous, doth not, for that very cause, become more *unhealthfull,* I inclined to believe, that *London* now is more *unhealthfull,* then heretofore, partly for that it is more populous, but chiefly, because I have heard, that 60 years ago few *Sea-Coals* were burnt in *London,* which now are universally used. For I have heard, that *Newcastle* is more *unhealthfull* then other places, and that many People cannot at all endure the smoak of *London,* not onely for its unpleasantness, but for the suffocations which it causes.

14. Suppose, that *Anno* 1569 there were 2400 souls in that parish, and that they increased by the *Births* 70, exceeding the *Burials* 58, it will follow, that the said 2400 cannot double under 200. Now, if *London* be less *healthfull* then the Country, as certainly it is, the *Plague* being reckoned in, it follows that *London* must be doubling it self by generation in much above 200: but if it hath encreased from 2 to 5 in 54, as aforesaid, the same must be by reason of transplantation out of the Country.

The Conclusion

It may be now asked, to what purpose tends all this laborious puzzling, and groping? To know,

1. The number of the People?
2. How many *Males* and *Females*?
3. How many Married, and single?
4. How many *Teeming* Women?
5. How Many of every *Septenary,* or *Decad* of years in *age*?
6. How many *Fighting* Men?
7. How much *London* is, and by what steps it hath increased?
8. In what time the housing is replenished after a *Plague*?
9. What proportion die of each general and perticular *Casualties*?
10. What years are Fruitfull, and Mortal, and in what Space, and Intervals, they follow each other?
11. In what proportion Men neglect the Orders of the *Church,* and *Sects* have increased?
12. The disproportion of Parishes?
13. Why the Burials in *London* exceed the Christnings, when the contrary is visible in the Country?

To this I might answer in general by saying, that those, who cannot apprehend the reason of these Enquiries, are unfit to trouble themselves to ask them.

2. I might answer by asking; Why so many have spent their times, and estates about the Art of making Gold? which, if it were much known, would onely exalt Silver into the place, which Gold now possesseth; and if it were known but to some one Person, the same single *Adeptus* could not, nay, durst not enjoy it, but must be either Prisoner to some Prince, and Slave to some Voluptuary, or else skulk obscurely up and down for his privacie, and concealment.

3. I might Answer; That there is much pleasure in deducing so many abstruse, and unexpected inferences out of these poor despised Bills of *Mortality;* and in building upon that ground, which hath lain waste these eight years. And there is pleasure in doing something new, though never so little, without pestering the World with voluminous Transcriptions.

4. But, I Answer more seriously; by complaining, That whereas the Art of Governing, and the true *Politiques,* is how to preserve the Subject in *Peace,* and *Plenty,* that men study onely that part of it, which teacheth how to supplant, and over-reach one another, and how, not by fair out-running, but by tripping up each other's heels, to win the Prize.

Now, the Foundation, or Elements of this honest harmless *Policy* is to understand the Land, and the hands of the Territory to be governed, according to all their intrinsick, and accidental differences: as for example; It were good to know the *Geometrical* Content, Figure, and Scituation of all the Lands of a Kingdom, especially, according to its most natural, permanent, and conspicuous Bounds. It were good to know, how much Hay an Acre of every sort of Meadow will bear? how many Cattel the same weight of each sort of Hay will feed, and fatten? what quantity of Grain, and other Commodities the same Acre will bear in one, three, or seven years *communibus Annis*? unto what use each soil is most proper? All which particulars I call the intrinsick value: for there is also another value meerly accidental, or extrinsick, consisting of the Causes, why a parcel of Land, lying near a good Market, may be worth double to another parcel, though but of the same intrinsick goodness; which answer the Queries, why Lands in the North of *England* are worth but sixteen years purchase, and those of the West above eight and twenty. It is no less necessary to know how many People there be of each Sex, State, Age, Religion, Trade, Rank, or Degree *&c.* by the knowledg whereof Trade, and Government may be made more certain, and Regular; for, if men knew the People as aforesaid, they might know the consumption they would make, so as Trade might not be hoped for where it is impossible. As for instance, I have heard much complaint, that Trade is not set up in some of the *South-western,* and *North-western* Parts of *Ireland,* there being so many excellent Harbours for that purpose, whereas in several of those Places I have also heard, that there are few other Inhabitants, but such as live *ex sponte creatis,* and are unfit Subjects of Trade, as neither employing others, nor working themselves.

Moreover, if all these things were clearly, and truly known (which I have but guessed at) it would appear, how small a part of the People work upon necessary Labours, and Callings, *viz.* how many Women, and Children do just nothing, onely learning to spend what others get? how many are meer Voluptuaries, and as it were meer Gamesters by Trade? how many live by puzling poor people with unintelligible Notions in Divinity, and Philosophie? how many by perswading credulous, delicate, and Litigious Persons, that their Bodies, or Estates are out of Tune, and in danger? how many by fighting as Souldiers? how many by Ministeries of Vice, and Sin? how many by Trades of meer Pleasure, or Ornaments? and how many in a way of lazie attendance, *&c.* upon others? And on the other side, how few are employed in raising, and working necessary food, and covering? and of the speculative men, how few do truly studie *Nature,* and *Things*? The more ingenious not advancing much further then to write, and speak wittily about these matters.

I conclude, That a clear knowledge of all these particulars, and many more, whereat I have shot but at rovers, is necessary in order to good, certain, and easie Government, and even to balance Parties, and factions both in *Church* and *State*. But whether the knowledge thereof be necessary to many, or fit for others, then the Sovereign, and his chief Ministers, I leave to consideration.

[The following lengthy tables appear in the original work as appendixes along with detailed instructions for reading them. Ed.]

The Table of Burials, and Christnings, 1604–1635

The Table of Casualties, 1647–1659 (by detailed cause)

The Table of Burials, and Christnings in *London*, 1636–1661

The Table of Males and Females for *London*, 1629–1660

The Table by Decads of years for the Country-Parish, 1569–1658

The Table of the Country-Parish, 1569–1588

The Table of Males and Females, 1589–1628

The Table of the Country-Parish, 1629–1658

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CHAPTER 3

JAMES LIND
(1716–1794)

Armies have been supposed to lose more of their men by sickness, than by the sword.

—James Lind, *A Treatise on the Scurvy*, 1753

James Lind, the son of a merchant, was born in Edinburgh, Scotland, in 1716. He apprenticed at the College of Surgeons in Edinburgh in 1731 and began serving as a naval surgeon eight years later. In 1747, while serving on the *HMS Salisbury* (engaged in patrols of the English Channel during the War of Austrian Succession), Lind carried out a controlled experiment on a cohort of seamen suffering from scurvy. He selected 12 men from the ship, each with similar symptoms of scurvy. The men were divided into six pairs, and each pair was given a different treatment. Lind noted no improvement in most of the subjects, minimal improvement among the men who were given cider, but complete recovery for the men receiving citrus fruits. While Lind's treatments and his expectation that citrus fruits would relieve the symptoms of scurvy were not original, he is credited with completing a controlled experiment, carefully observing all subjects in the same fashion, and documenting the dramatic recovery of the seamen on citrus fruits.

The following year, Lind returned to the University of Edinburgh to complete his medical studies. He then established a private practice in Edinburgh and remained there for a decade, writing up his observations on the scurvy and publishing them in 1754. In 1757, the same year he was elected treasurer of the Royal College of Physicians of Edinburgh, he published *An Essay on the Most Effectual Means of Preserving the Health of Seamen in the Royal Navy*. This book established the discipline of naval hygiene, bringing the appalling living conditions and diet of seamen to attention. In 1758, Lind was appointed physician to the Naval Hospital at Haslar in Gosport, on the south coast of England. Five years later, he published *Two Papers on Fevers and Infections*. This treatise provided a medical history of the Seven Years' War. In it, Lind provided descriptions of typhus fever among sailors at sea and suggested the use of wood smoke and gunpowder as disinfectants. In 1768, Lind published his last major work, *An Essay on Diseases Incidental to Europeans in Hot Climates.* It provided a synopsis on disorders present in each colony and suggested means to avoid infections.

It took the Royal Navy 42 years to accept the validity of Lind's work on scurvy because the navy's Sick and Hurt Board received a great number of treatises on the disease, many with conflicting claims. The common treatment for scurvy at that time was wort (malt). Malt is rich in vitamin B complex, and seamen with general nutritional deficiencies may have responded at least partially, if not completely, to that treatment. Thomas Cook's second voyage, from 1771 to 1775, seemed to further justify the use of wort. Cook lost only 4 of 118 seamen over three years at sea (3 to accidents and 1 to consumption). His ships carried both rob (condensed fruit juice) and wort when they left England, but Cook's success in keeping his men healthy was more likely because he stocked up on fresh fruits and vegetables at every opportunity. His testimony to the navy upon his return supported the use of wort, although he credited Lind with the recommendation to provide fruit juice and fresh vegetables. The navy decided upon wort, sauerkraut, and potable soup for its seamen, determining that rob was probably ineffective and too expensive.

During the American Revolution, logs were kept about the prevention and treatment of scurvy among British seamen. The wartime records were later reviewed, providing the navy with sufficient and accurate records for use in determining successful scurvy preventives and treatments. At the end of the review, an Admiralty order recommended the use of lemon juice.

Lind died on July 13, 1794, in Gosport, Hampshire, England, having retired from active practice 11 years prior.

A Note on the Text

Typical of writing of the period, the *Treatise* contains lengthy discussions of the experiences that other physicians, sea captains, and entire fleets had with treating scurvy. It also describes antiscorbutic treatments used by others, with Lind challenging their findings and listing their flaws. We present here that part of Lind's *Treatise* that records what is apparently the earliest record of a controlled clinical trial. Although Lind did not practice randomization, his means of assigning treatment status appears equivalent to it. Only one other such trial has been identified prior to Lind (a comparison of diets in the Bible, in the book of Daniel, found that a kosher diet appeared to be better than a nonkosher one). However, it is with Lind that we begin to trace the development of modern methods of clinical research—providing the firm scientific footings critical to the formulation of rational health policy focused on improving the public's health.

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A Treatise on the Scurvy
(1753, Abridged)

Preface (First Edition, 1753)

The subject of the following sheets is of great importance to the nation; the most powerful in her fleets, and the most flourishing in her commerce, of any in the world. Armies have been supposed to lose more of their men by sickness, than by the sword. But this observation has been much more verified in our fleets and squadrons; where the scurvy alone, during the last war,[1] proved a more destructive enemy, and cut off more valuable lives, than the united efforts of the French and Spanish arms. It has not only occasionally committed surprising ravages in ships, and proved the total destruction of the most powerful fleets (of which that of Admiral Hosier's when at the Bastimentos is a memorable and dreadful instance), but almost always affects the constitution of sailors when long at sea; and where it does not rise to so visible a calamity, yet it may often make a powerful addition to the violence of other diseases. . . .

CHAPTER IV
The prophylaxis, or means of preventing this disease, especially at sea

It being of the utmost consequence to guard against the first approaches of so dreadful an enemy, I shall here endeavor to lay down the measures proper to be taken for this end, with that minuteness and accuracy which the importance of the subject, and the preservation of so many valuable and useful lives, justly demand; and at the same time shall, as much as possible, avoid offering any thing that may be judged impracticable, or liable to exception, on account of the difficulty of disagreeableness of complying with it. And, *lastly*, I shall propose nothing dictated merely from theory; but shall confirm all experience and facts, the surest and most unerring guides.

What I propose is, first, to relate the effects of several medicines tried at sea in this disease, on purpose to discover what might promise the most certain protection against it upon that element. The medicine which succeeded upon trial, I shall afterwards confirm to be the surest perservative [*sic*], and most efficacious remedy, by the experience of others.

I shall then endeavour to give it the most convenient portable form, and shew the method preserving its virtues entire for years, so that it may be carried to the most distant parts of the world in small bulk, and at any time prepared by the sailors themselves: adding some farther directions, given chiefly with a view to inform the captains and commanders of ships and fleets, of methods proper both to preserve their own health, and that of their crew.

It will not be amiss further to observe, in what method convalescents ought to be treated, or those who are weak, and recovering from other diseases, in order to prevent their falling into the scurvy; which will include some necessary rules for resisting the beginnings of this evil, when, through neglect or want of care, the disease makes its appearance in a ship.

As the salutary effects of the prescribed measures will be rendered still more certain, and universally beneficial, where proper regard is had to such a state of air, diet, and regimen, and may contribute to the general intentions of preservation or cure; I shall conclude the precepts relating to the preservation of seamen from this disease, with shewing the best means of obviating many inconveniences which attend long voyages, and of removing the several causes productive of this mischief.

The following are the experiments.

On the 20th of *May*, 1747, I selected twelve patients in the scurvy on board the *Salisbury* at sea. Their cases were as similar as I could have them. They all in general had putrid gums, the spots and lassitude, with weakness of their knees. They lay together in one place, being a proper apartment for the sick in the *fore-hold*; and had one diet in common to all, *viz.*, water-gruel sweetened with sugar in the morning; fresh mutton-broth often times for dinner; at other times light puddings, boiled biscuit with sugar, &c. and for supper, barley and raisins, rice and currants, sago and wine, or the like. Two of these were ordered each a quart of cyder a-day. Two others took twenty-five drops of *elixir vitriol*[2] three times a-day upon an empty stomach; using a gargle strongly acidulated with it for their mouths. Two others took two spoonfuls of vinegar three times a-day, upon an empty stomach; having their gruels and their other food well acidulated with it, as also the gargle for the mouth. Two of the worst patients, with the tendons in the ham quite rigid (a symptom none the rest had) were put under a course of sea-water. Of this they drank half a pint every day, and sometimes more or less, as it operated, by way of gentle physic. Two others had each two oranges and one lemon given them every day. These they eat with greediness, at different times, upon an empty stomach. They continued but six days under this course, having consumed the quantity that could be spared. The two remaining patients, took the bigness of a nutmeg three times a-day, of an electuary[3] recommended by an hospital-surgeon, made of garlic, mustard seed, horseradish (*rad. raphan.*), balsam of Peru, and gum myrrh; using for common drink, barley-water boiled with tamarinds; by which, with the addition of *cremor tartar*,[4] they were gently purged three or four times during the course.

The consequence was, that the most sudden and visible good effects were perceived from the use of the oranges and lemons; one of those who had taken them, being at the end of six days fit for duty. The spots were not indeed at that time quite off his body, nor his gums sound; but without any other medicine than a gargle of *elixir vitriol*, he became quite healthy before we came into *Plymouth*, which was on the 16th of *June*. The other was the best recovered of any in his condition, and being now deemed pretty well, was appointed to attend the rest of the sick.

Next to the oranges, I thought the cyder[5] had the best effects. It was indeed not very sound. However, those who had taken it were in a fairer way of recovery than the others at the end of the fortnight, which was the length of time all these different courses were continued, except the oranges. The putrefaction of their gums, but especially their lassitude and weakness, were somewhat abated, and their appetite increased by it.

As to the *elixir of vitriol*, I observed that the mouths of those who had used it by the way of gargle were in a much cleaner and better condition than many of the rest, especially those who used the vinegar; but perceived otherwise no good effects from its internal use upon the other symptoms. I indeed never had a great opinion of the efficacy of this medicine in the scurvy, since our longest cruise in the *Salisbury*, from the 10th of *August* to the 28th *October* 1746, when we had but one scurvy in the ship. The patient was a marine, (one Walsh); who, after recovering from a quotidian ague[6] in the latter end of September, had taken the *elixir vitriol* by way of restorative for three weeks; and yet at length contracted the disease, while under a course of a medicine recommended for its prevention.

There was no remarkable alteration upon those who took the electuary and tamarind decoction, the sea-water, or vinegar, upon comparing their condition, at the end of the fortnight, with others who had taken nothing but a little lenitive electuary and *cremor tartar* occasionally, in order to keep their belly open, or some gentle remedies in the evening, for relief of their breast. Only one of them, while taking the vinegar, fell into a gentle flux at the end of ten days. This I attributed to the nature of the disease, rather than to the use of the medicine. As I shall have occasion elsewhere to take notice of the effects of other medicines in this disease, I shall here only observe that the result of all my experiments was, that oranges and lemons were the most effectual remedies for this distemper at sea. I am apt to think oranges preferable to lemons, though perhaps both given together will be found most serviceable.

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CHAPTER 4

GEORGE BAKER
(1722–1809)

[T]he cause of this Colic is not sought for in the pure Cyder; but in some, either fraudulent, or accidental, adulteration.

—George Baker, *Endemial Colic of Devonshire*, 1767

George Baker was born in Devonshire, England, on February 8, 1722, to the Reverend George Baker, vicar of Modbury, and his wife Bridget. The young Baker received an Eton education, followed by college at Cambridge (King's College). He graduated from the latter with a B.A. in 1745, an M.A. degree in 1749, and an M.D. in 1756. At the invitation of many friends, Baker established a medical practice in Stamford, Lincolnshire; however, in 1761, he relocated his practice to London.

In London, Baker developed a reputation as both a superb physician and a Latin scholar who was appreciated for his clarity and logic. On June 29, 1767, Baker presented the results of his investigation into the colic associated with the area where he was raised, Devonshire, as an oration to the College of Physicians. The presentation was published in *Medical Transactions* the following year, an impressive feat considering the state of medical publishing at the time. Baker concluded that the cause of the colic was lead contamination of apple juice. When lead ceased to be used, the Devonshire colic disappeared into the history books.

Perhaps based on the strength of his work on the Devonshire colic, Baker became a Fellow of the College of Physicians, serving as censor four times, the Harveian orator once, and president from 1785 to 1795. He served as the physician to the queen's household, the queen, and then King George III. In this regard, he shared an honor with John Snow (see Chapter 12). In 1776, Baker was made a baronet and was subsequently inducted as a Fellow into both the Royal Society and the Society of Antiquaries.

Sir George was the only physician attending George III when the king first demonstrated signs of mental illness in 1788 (portrayed in the movie *The Madness of King George III*). He attended the king throughout his illnesses, though some professional rivalry was documented with Dr. Francis Willis, a clergyman with a reputation for treating the insane at his private asylum. George III suffered from porphyria, although his symptoms may have been aggravated by the treatment of his doctors.

Baker died on June 15, 1809, at the age of 87 years. He is buried at St. James's, Piccadilly. A memorial tablet to the north of the communion table at St. James's states, "Near this spot are deposited the remains of SIR GEORGE BAKER, BART."

A Note on the Text

Devonshire had been the center of the English apple cider industry since the 1300s. Cider was developed as a means of drinking apple juice in an era in which refrigeration was nonexistent. The fermented beverage was traditionally consumed by Devonians, and well before James Lind established the role of limes for preventing scurvy (see Chapter 3), cider was consumed by British seamen on the high seas as a means of preventing the condition. With the expansion of British trade during the 1600s and 1700s, the need for apple cider increased considerably—and with it the economic fortunes of Devon. The increasing wealth of Devonshire residents was associated with improved health, with one exception—the Devonshire colic.

First noted in the 1600s, Devonshire colic was always painful, and it was also sometimes fatal. The first written reports date back to 1655, and they sometimes associated the colic with the consumption of apple cider. Many suggested the acidity of the drink caused the colic.

Baker began his own investigation in the 1760s and quickly observed the similarities between Devonshire colic and lead poisoning. He observed that acidity, per se, did not merit consideration as the cause of the condition, noting the lack of colic among a variety of population groups consuming acidic drinks and foods. Baker next examined the epidemiology of the disease, finding that colic cases occurred (or at least were admitted to the hospital) around the time cider manufacture began each year and abated shortly after manufacturing ceased.

The process of cider manufacture was the next item Baker considered, meticulously noting the presence of lead in each element of the machinery used on the production process. He observed the degree to which lead might enter into the cider. Finally, he conducted several experiments to demonstrate the leaching of lead into the cider. Baker's correspondence with Benjamin Franklin notes that Franklin reported on the use of "leaden worms" in the production of spirits; the effects were considered so ominous that legislation was passed to eliminate the practice.

Baker's conclusion that the use of lead in cider manufacture was causal for developing colic was generally well received—except in Devonshire. Cider manufacturers were enraged and opposed Baker's view. Nonetheless, Baker's logic carried the day; the use of lead in cider production ceased, and alternative materials were identified for cider production machinery. By 1818, lead was no longer part of the manufacture of Devonshire apple cider, and the Devonshire colic became a disease of the past.

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An Essay Concerning the Cause of the Endemial Colic of Devonshire
(1767)

A very small acquaintance with the writings of Physicians is sufficient to convince us, that much labour and ingenuity has been most unprofitably bestowed on the investigation of remote and obscure causes; while those, which are obvious and evident, *quæ ante pedes sunt*,[1] which must necessarily be acknowledged as soon as stumbled upon, have been too frequently overlooked and disregarded. Such a spirit of investigation has, in several instances, been the parent of dangerous error in practice; inasmuch as Men are apt to be as partial to their own offspring; and seldom forget opinions at the bed-side, which have been the result of much contemplation at home. It must however be acknowledged, that such a spirit is a fault not so much to be imputed to the present, as it was to the last age. We have now learned to attend to Nature; to observe diseases, and the genuine effects of medicines on the human body; and to make experiment the great *basis* of our reasoning. And although, in many cases, we subscribe to the doctrine of that sect of Physicians, who, according to Celsus, called themselves 'Empirics,' *ab experientia,* that *non intersit quid morbum faciat, sed quid tollat*;[2] yet we are not such Empirics, in the modern sense of the word, as to pay no regard to those causes, which are manifest and within our reach; such causes more especially, as lead us directly either to the cure of diseases, or to the prevention of them.

With respect to the provincial disease, which is the subject of this essay, I shall at present content myself with considering its origin. And if I am not mistaken in that, it would seem that, in this instance, *cognitio causæ morbum tollet*;[3] that an obvious method is pointed out, by which this colic may become no longer an endemial disease in one part of England; and perhaps, in other parts, less frequent than it is at present. A malady, so formidable as well in its immediate effects, as in its more distant consequences, it is an office of humanity, as much as possible, to prevent. We may gain credit even in avoiding an enemy of superior force; and when we find ourselves unequal to the contention, it is a kind of victory to make our escape,—

"*fallere & effugers est triumphus*."[4]

The earliest account of the Devonshire colic, which I have met with, is in Dr. William Musgrave's *Dissertatio de Arthritide Symptomatica*, published in the year 1703.

In the fifth section of the tenth chapter *de Arthritide ex calicâ*, is the following passage:

> "Alia vero colica, apud Damnonium, ex pomaceo immiti et acido, nimis usurpato, derivatur; id quod ex eo liquet, siquidem illos solum infestat, qui potioni isti assuevere, eademque ratione quæ sunt assueti: sic ut iis temstatibus, quae pomaceo abundant, crescat, & in vulgus ea grassetur; contra vero, Pomona copiam negante, rarius obversetur."[5]

It seems very particular, that Dr. Musgrave should say so much of this colic, which is represented to be the effect of cyder; and not mention those essential and pathognomonic symptoms, by which it is at this time distinguished. Are we to suppose that, when Dr. Musgrave lived, this species of colic had not been observed to terminate in palsy, or epilepsy? Or is it more probable, that his attention was so engrossed by the general subject of his dissertation, that he forgot to mention such remarkable *phænomena*? That he was well acquainted with a disease exactly similar to Dr. Huxham's *morbus colicus Damnoriorum*, namely the colice of Poitou, is very certain; for in the fourth history of the same tenth chapter, he mentions the case of a gentleman, who

> "ætatis sore, colica, quam Pictonicam appellant, aliquamdui vexatus, ex more et progressu istius mali ordinario, incidit in paralysin; artus exinde marcidos, graciles, *immovable* habens; per reliquum vitæ clinicus. Paralysi fu ejus initium accesserunt dolores erratici, incerti, horum, illorum artuum internodia cruciantes, automno et tempestate pluvia maximopere sævientes, et ad amussim rheumatismum simulantes."[6]

It is indeed possible, that Dr. Musgrave might not often have seen the colic, which he mentions as peculiar to the drinkers of cyder; for, as I am informed, orchards were not in his time much cultivated in the country near Exeter, where Dr. Musgrave resided; and there was not county-hospital at that time established. And Dr. Huxham testified in the year 1739, that there was at that time ten times more cyder made and drunk in the County, than there had been about thirty or forty years before.

Dr. Huxham's *Opusculum de morbo colico Damnoniorum*,[7] which he first published in the year above-mentioned, contains a very full description of the malady, which is the subject of our present inquiry. He informs us, that

> "in the beginning of the Autumn of 1724, it spread itself over all the county of Devon, among the Populace especially, and those who were not very elegant and careful in their diet; and that, though it

> may not rage with the same degree of violence, and may affect a vastly less number of People, yet it infests that County more or less every Autumn."

Whoever persueth Dr. Huxham's description, will readily determine the *morbus colicus Damnoniorum* to be precisely the same disease, which in the year 1617, was described by Francis Citois, a native of Poitiers, afterwards Physician to the King of France, and to the Cardinal Duc de Richelieu, under the title of *novus & popularis apud Pictones dolor colicus biliosus*. Indeed it seems to be acknowledged by Dr. Huxham, that what is called Colica Pictonum, "which kind of disease," says he, "is very common in the West-Indies," is similar to the disease which he describes, "arising from a similar cause, to wit, too[8] great a use of the very acid juice of lemons, and requiring much the same method of cure."

Dr. Huxham refers the cause of the Devonshire colic principally to a very gross, essential, acid salt, or tartar, with which the expressed juice or apples, whilst unfermented, abounds. He thinks that

> "by long and frequent drinking a liquor of this kind, such a quantity of crude, gross tartar is thrown into the blood, that it thence becomes very acrid; and not only the blood, but, from that impure source, all the humours thence secreted. So that instead of a very soft, lubricating *mucus* separated by the glands, discovered by Dr. Havers, we have as it were a sharp, coagulated matter, whence arises a great pain in the joints, and impotence of their motion.—Instead of an exceeding soft lymph to moisten the nerves, a corrosive ichor;[9] and hence epileptical attacks. Moreover, the blood being saturate with such a great quantity of salts, they attract one the other strongly, and form greater *moleculæ* than can pass through the lymphatic arteries, scarce indeed through the sanguineous capillaries; hence various obstructions, and great irritation on the nervous extremities. At length even the very Bile, that variously useful balsam of the body, becomes corrupted and quite enervated by the superabundant apple-acid, though in its natural state it was designed to correct acidity."[10]

Thus I have extracted a specimen of Dr. Huxham's doctrine; and for the remainder of his very ingenious theory I shall refer you to the treatise itself; where you will find a sentiment, which perhaps is applicable on the present occasion.—

> "Sine experientia vana omnis theoria, bella sit utcunque.[11]

For, notwithstanding the deference, which I always pay to the authority of this celebrated Physician, I have for some time conceived doubts concerning the solidity of this doctrine. When I have considered, that there is not the least analogy between the juice of apples, and the poison of lead; and that this colic Devonshire is precisely the same disease, which is specific effect of all saturnine preparations; it has not seemed to me at all probable that two causes, bearing so little relation to one another, should make such similar impressions on the human body. No author, whom I have had an opportunity of consulting, has given any intimation of having conceived the same suspicion with myself, except only the anonymous author (supposed to be M. Bouvart) of *Examen d'un livre qui a pour titre T. Tronchin de Colica Pictonum, par un Medecin de Paris*.[12] This writer says, in a cursory manner, and without seeming to lay any stress on what he throws out,

> "Il est possible, que les vins, dont parle Citois, et les cidres, dont parle M. Huxham, aient etè, sans qu'ils l'aient pu decourvrir, alterès avec la litarge, ou quelque autre matiere semblable."[13]

It is evident however from what this Author afterwards says, in the forty-sixth page, that he was very far from forming any settled opinion on this subject.

> "Ces trois causes, scavoir la bile, les matieres minerales venimeuses, et les vins verds et austeres, quoique differentes en apparence, produisent, malgrè ce qu'en peut dire M. Tronchin, des coliques à peu près de même espece."[14]

But to return to Dr. Huxham.—And first, how much soever our Cyder may agree with Rhenish[15] and Moselle wines in the circumstance of containing a large quantity of essential salt, of a similar figure; no argument, from analogy, will be here valid, unless it can be shewn that Rhenish and Moselle wines have ever produced the colic of Poitou in an unadulterated state.[16]

Secondly, if Cyder is the cause of this disease, as being an acid, why is the colic of Poitou very little known in the eastern countries, where the Turks, whose religion obliges them to abstain from wine, drink every day very large quantities of an acid sherbert? Does the experience of Jockeys, who, in order to reduce themselves to a certain standard of weight by sweating, are said to drink largely of vinegar, strengthen such an observation? Do find it to be true, that children, and valetudinary[17] people, and particularly cholorotic[18] girls, whose *primae viae*[19] abound with acid, are on that account subject to this colic? Is not a *Diarrhœa*, or *Cholera*, the ordinary effect of eating unripe fruit immoderately? What reason can be given, why the poorer inhabitants of the counties of Worcester, Gloucester, and Hereford, who use, as their common drink, a weak acid cyder, are subject to no such colic? Why is this disease no longer endemic in the province of Poitou? Is it that the grapes are brought to more maturity, than they were formerly? Has the Sun more power now, than in the time of Citois? Why, in the Bahama-islands, is this disease unknown? I am informed by a gentleman, who lived there many years, that this has been the case, ever since rum has been no longer distilled in those islands. The same gentleman informs me, that the inhabitants drink very large quantities of small punch, made extremely acid with the juice of limes; the labouring people to the amount of two gallons of it every day. And lastly, is it reasonably to be suspected, that the essential salt of a vinous liquor can raise such tumults in the bowels, whether by corrupting the Bile, or otherwise; when it is vulgarly known, even among the Miners in Derbyshire, that Patients, afflicted with this same disease, do not receive a more immediate, or more important relief from any medicine whatever, than by taking large and repeated doses of this very essential salt, the *Cremor Tartari*;[20] and when it appears, that Dr. Hillary greatly depended on it for the cure of the dry-belly-ach in the West-Indies? Zeller, in his *docimasia, signa causæ, & noxa vini lithargyrio mangonisati*, gives an account of the revival of the adulteration of wine with litharge[21] in the Duchy of Wirtemberg, in the beginning of the present century. In this dissertation he asserts, that though the wines, in the neighborhood of Tubinga, were as acid as vinegar, the inhabitants had long drunk them with impunity, 'till this fraud was introduced.

> "Constat viciniam nostram, ubi alias montes lachrymantur, acetum, et istiusmodi vina immatura et acida per plures annos, imo lustra ab incolis & militbus largiter hausta fuerunt, ab omnibus tamen his symptomatibus penitus liberam fuisse, cum a fuco quoque libera fuerit: Imo in ipsa hac nostra Civitate quae ante duo lustra truculentia hac tantum non oppressa fuit, postquam fraudem hanc plurimi tam Vietores, quam Caupones, tecte quidem exercuerunt, omnes isti, qui a Cauponibus vinum vel non emerunt, vel in eorum aedibus non biberunt, a torminibus et cruciatibus hisce immunes evaserunt; licet eorum domestici per aliquot annos austerum & acidissimum hauserint vinum, ut acidius gustari vel dari nequeat; aliis interea, quos dulcedo inescavit, miserrime patientibus, aut evervatis, elumbibus redditis, pendulis artubus et resolutis incedentibus, aut neci traditis; plurimi enim miserrime perierunt."[22]

The experiment, mentioned by Zeller proves nothing against the general wholesomeness of acids. Upon his giving to a Dog three ounces and an half of very strong vinegar, the respiration of the animal immediately became sonorous and difficult; and he died in the third hour after he had swallowed the vinegar, having thrown up great quantities of froth, which at last was mixed with blood. The Dog being opened, no signs of inflammation appeared in the stomach: the mischief is described to have been in the lungs only. Some of the vinegar probably found its way into the lungs; and suffocation seems to have commenced in the very act of swallowing. Whereas Brunnerus, (*Ephermerid. Germanic. an. 4. Observat. 92.*) who killed a Dog with an ounce of powder of litharge, dissolved and boiled in vinegar, found the effects of that poison to be principally in the stomach, intestines, urinary bladder, and the rest of the *viscera* of the *abdomen*.

I shall only add one more observation concerning acids. Physicians, who have resided some time in the hotter countries, have testified, that there are no better remedies against spasms, dysenteries, and the other endemial diseases in hot climates, than the acid vegetables, with which Nature has most liberally supplied the warmer countries. This opinion is expressed in a strong manner by Jacobus Bontius in his *Historia Naturalis Indiæ Orientalis, lib. vi. cap. 27*.

> "Videtur Natura voluisse exprofesso multas acidas et constringentes herbas e terra producere contra violentos & endemios morbos, dysenteriam nempe, choleram, & spasmum, plerumque a Bile ortos: ut quasi digito monstraret, ubi haec vel similia mala nascuntur, ibi locorum remediorum manifesta et etiam occulta qualitate pugnantium penuriam non fore."[23]

It seems therefore not to have been without sufficient foundation, that I have for some time suspected, that the cause of this Colic is not sought for in the pure Cyder; but in some, either fraudulent, or accidental, adulteration.

Upon inquiry, I find that the disease is very common all over the county of Devon; but that it particularly infests those parts of the county, where the greatest quantities of Cyder are made. I likewise find that it is not only common among the lower class of inhabitants; but that it is much more frequent among people of all ranks, than in other parts England; and that it is not entirely confined to that autumnal season. Not long ago I had an opportunity of seeing several wretching victims to this cruel disease; who answered to the representation drawn by Citois.

> "Per vicos, veluti larvae, aut arte progredientes statuae, pallidi, squallidi, macilenti conspiciuntur, manibus incurvis et suo pondere pendulis, nec nisi arte ad os et caeteras supernas partes sublatis, ac pedibus non suis, fed crurum musculis, ad ridiculum, ni miserandum, in cessum compositis, voce clangosa & strepera."[24]

I lately received from Dr. Andrew of Exeter the following Account of all Patients, under this disease, admitted into the hospital at Exeter since September 1762.

From Sept. 1762 to Sept. 1763	—72
Sept. 1762 to — 1764	—75
Sept. 1764 to Lady-Day 1766	—86
Lady-Day 1766 to July 6, 1767	—52
	285

Of this number 209 were cured.

Dr. Andrew likewise informs me, that Patients are brought to the Exeter hospital from all parts of the county; but chiefly from those parts, where most cyder is made.—That the most violent symptoms of this disorder, such as pain and costiveness, are generally removed, before the sick are brought to the hospital; and that nothing commonly remains but a paralytic weakness in the arms. Dr. Andrew adds, "I have known this complaint cured radically; tho' I confess, a return often happens. When the disease proves obstinate, we always endeavor to get our Patients into the hospital at Bath; the Bath-water, tho' not a specific, being esteemed by us the most effectual remedy, both internally and externally used."

According to my information, eighty Patients, under the effects of the Devonshire colic, were admitted into the Bath hospital in the course of the last year; forty of whom are said to have been cured, and thirty-fix sent away greatly relieved. I likewise am informed from the Bath hospital, that the proportion of such Patients from Devonshire, to that from the counties of Hereford, Gloucester, and Worcester, is generally as eight to one.

In some letters, which I have lately received from Dr. Wall, of Worcester, the following facts are mentioned. "The counties of Hereford, Gloucester, and Worcester, are not, so far as I know, subject to the colic of Poitou, or any other endemic illness, unless it may be the rheumatism; which, I think, the inhabitants of Herefordshire are more liable to, than those of some other counties. There is no Lead, which can give occasion to that colic, used in any part of the *apparatus* for grinding or pressing the apples, or fermenting the liquor. Once indeed, in a plentiful year of apples, I knew a Farmer, who wanting casks, filled a large leaden cistern with new cyder, and kept it there, till he could procure hogsheads sufficient to contain the liquor. The consequence was, that all who drank of it were affected by it as the Lead-workers usually are. We had eleven of them, at one time, in our Infirmary.

"I have lately had two or three Patients in that distemper, occasioned by their having drunk cyder made in a press covered over with Lead. But this fact of a cyder-press covered with Lead, is a singular, and perhaps the only instance of the kind in this part of England. It happened in a part of the county of Worcester, adjoining to Warwickshire, where very few apples grow; and the bed of the press being therefore cracked by disuse the sagacity of the Farmer contrived this covering, to prevent a loss of his liquor. In general, the cyder-drinkers with us are healthy and robust; but for the most part lean. The liquor is clear, and passes off readily by urine and perspiration; which enables the common people to drink immense quantities of it when at labour, to the amount of several gallons in day. I have heard it observed by a Physician, late of this place, who was much concerned in the cure of Lunatics, that more of those unhappy Persons came to him from Herefordshire, than any other place. The fact, if true, may possibly arise from the quantity drunk, rather than the quality."

Were the *apparatus* for making cyder the same in all the cyder-counties, it would appear very remarkable, that the inhabitants of one county should experience such terrible effects from the use of this liquor, while those of the other counties drink it with impunity. But, if we inquire into the method of making cyder in the county of Devon, we shall be able to conjecture with some degree of probability what it is that occasions such a difference. The large circular trough, is generally composed of several pieces of moor-stones, cramped together with iron, some melted Lead being poured into the interstices. It frequently happens, that these stones, which are thus to be joined, are unequal, and do not correspond with each other; so that considerable chasms are left between them; and these chasms are filled up with Lead. In this case the apples, ground by the pressure of the roller, immediately come in contact with no small quantity of this poisonous mineral.

It is likewise common, in several parts of the county, either to line the cyder-presses entirely with Lead, in order to prevent their leaking; or to make a border of Lead quite round the press, in order to receive the juice of the apples, and to convey it into a vessel, made of wood or stone, placed underneath. And in many other places, where these methods are not used, it is common to nail sheet lead over any cracks or joints in the presses; and likewise to convey the juice of the apples from the presses in the leaden pipes. Moreover I am informed, that it is the practice of some Farmers, in managing their weak cyder, made early in the year, before the apples are ripe, to put a leaden weight into the casks, in order to prevent the liquor from growing sour; and that this cyder is the common drink of their servants and labourers. But I am willing to believe, that this pernicious method of adulteration (against which fever laws have been enacted, as well in France as in Germany, and which crime, in both countries, is deservedly punished by death) is not often practised by our countrymen.

"Dii meliora piis, erroremque hostibus illum!"[25]

Dr. Wall informs me, that in some parts of the counties of Hereford, Gloucester, and Worcester, the mills, in which the apples are ground, being 16, 18 and 20 feet in diameter, consist of several pieces of stone or timber, joined together with cramps of iron, fastened with Lead: but that these cramps are fixed in the *bed* of the mill, or on the outside of the curb, and not in the groove where the apples are ground. The same Gentleman observes, that, if many apples, full of juice, lie long on the *bed* of the mill, (where the apples are placed in an heap, that they may be ready to be thrown into the groove, [*sic*]) some of which may perhaps be rotten, others bruised in the gathering, and a moisture spread over the whole, from the fermentation and sweating of the fruit, it may perhaps be doubted, whether there some part of the Lead, used in the cramps, may not be dissolved; tho' it must be, at most, in a quantity extremely small; there being but very little Lead used in the junctures; and the surface exposed to the apples being almost imperceptible. But I am informed by another person, that in many parts of Herefordshire, and the neighboring counties, the stones of the mills, are joined together with putty; (which is whiting, mixed with oil into a tough paste) and that neither iron nor Lead are originally used in the construction of them; but that, if any of the joints, in wearing, happen to start (which is sometimes the case) they are repaired with iron cramps fastened with lead.

These facts having been well ascertained, I determined to make use of the first opportunity, which might occur, of informing myself by experiment, whether or no there are really marks of solution of Lead in the cyder of Devonshire. Being therefore, in the month of October 1766, at Exeter, I procured some of the expressed juice of apples, as it flowed from a cyder-press, lined with Lead, in the parish of Alsington. On this I made and repeated several experiments by means of the *atramentum sympathetiticum*, or *liquor vini probatorius* described by *Neuumann*; and of the volatile tincture of sulphur. These experiments entirely satisfied me, that the Must contained a solution of lead. The same experiments were made of some cyder of the preceding year. This likewise shewed evident signs of lead contained in it; but in less proportion than in the Must.

But, being unwilling to make any positive assertion, solely on the authority of my own trials, more especially as I had been under the influence of a preconceived opinion; I brought with me to London some of the same Must, which I had examined at Exeter. This Must, together with some Devonshire cyder of the preceding year, which I purchased of the maker, (who assured me that he used no Lead in any part of the apparatus for making cyder, except only what is necessary for composing the trough, as was mentioned above,) were the subject of some experiments, in making which, Dr. Saunders, in an ingenious Gentleman, who teaches Chemistry, kindly gave me his assistance.

Before I give an account of the several experiments, which we made, in order to ascertain this adulteration, it may be proper to make a few observations, which will perfectly explain the mode of union, which takes place between wine, or cyder, and lead.

The expressed juice of the grape, or of the apple, has a considerable quantity of acid united with the saccharine matter. This juice, when subjected to fermentation, has its acid, during the progress of that fermentation, gradually assimilated and converted into an alcohol or inflammable spirit. But if the original juice, or Must, be crude and acid, without having much saccharine matter in it, the native acid is with difficulty assimilated; or, when it arrives at the proper period of assimilation, it does not remain there stationary, but hastens on to the acetous fermentation. When lead is added to such wines, their acidity is covered; a sweetness is communicated to them; and their acetous fermentation is checked. The richer wines, of which the original juice contains a larger proportion of saccharine matter, are less liable to adulterations of this kind, than the poorer wines of northern climates, such as the Rhenish and the Moselle wines, and our English cyder.

It is here to be observed, that the vegetable acid, either in its native state of Must, or in its fermented state of vinegar, or in its intermediate state of cyder, very readily receives an impregnation from Lead, whether it be applied in its metallic or calcined state. We are therefore to consider Lead, when united wines, as in the condition of *saccharum Saturni*.[26]

By attentively observing the variety of changes produced by certain bodies, when added to a solution of *saccharum Saturni*; and by applying these observations to the wines, which are the most frequent subjects of this adulteration, Chemists have been enabled to detect such frauds, wherever they have existed.

Experiment I

A small quantity of Devonshire cyder being exposed upon clean paper to the fumes of the volatile tincture of sulphur, became immediately of a darkish colour, approaching to black. And we could only imitate this colour by exposing a dilute solution of *saccarum Saturni* to the same fumes. A small quantity of cyder, made in the county of Hereford, exposed in like manner to the same fumes, exhibited no such appearance, until a few drops of a solution of *saccharum Saturni* were added to it.

Observation I

From this experiment we are to understand that the acid, before united with the Lead in the cyder, and the volatile alkali in the tincture of sulphur, mutually attracted each other; and that it was the precipitate of the Lead united with the sulphur, which produced the dark colour above-mentioned.

Experiment II

A small quantity of *Hepar Sulphuris* (prepared by digesting together in a sand-heat one ounce of orpiment,[27] and two ounces of quick-lime, with twelve ounces of water, in a closed vessel) being added to some Devonshire cyder, in a few minutes occasioned a darkish colour in the body of the liquor, approaching to black; and the whole became very opake. No such change was produced in the cyder of the county of Hereford, until a few drops of a solution of *saccharum Saturni* were added; when the same appearance, which was produced in the Devonshire cyder, was perceived.

Observation II

The reasoning, made use of in the former observation, is applicable here. The decomposition of the *saccharum Saturni* and of the *Hepar Sulphuris* was effected by the same laws of elective attraction.

Experiment III

To a small quantity of Devonshire Cyder a few drops of *Hepar Sulphuris* (prepared by boiling equal parts of fixed vegetable alkali and sulphur together in water) were added; and a precipitation of a very dark colour was produced.

When some Herefordshire cyder was treated in the same manner, the precipitate produced was as white as milk; and it was only upon the addition of a few drops of a dilute solution of *saccharum Saturni*, that a precipitate of the same colour with the former could be obtained.

Observation III

There is some nicety required in making this experiment. The *Hepar Sulphuris* is not to be added in any large quantity; for as all the lead is precipitated upon the first addition, it is easy to perceive the several successive shades of colour in the precipitate, until all the lead is separated; and then the precipitate, upon a farther addition of *Hepar Sulphuris*, assumes the whiteness of the precipitate obtained from the Herefordshire cyder, which entitles it to the appellation of *Lac Sulphuris*.[28] If a large quantity of *Hepar Sulphuris* be at once added, the whiteness of the too copious precipitate is such, as to render the dark colour of what is first precipitated imperceptible.

Experiment IV

Some Devonshire cyder was examined by means of the volatile tincture of sulphur, as in Experiment III. A very dark coloured precipitate was obtained. A similar precipitate could be only obtained from Herefordshire cyder, after that a weak solution of *saccharum Saturni* was added to it. Some of the Must (taken from the press in the parish of Alsington, as was mentioned above) treated in the same manner with the cyder, produced precipitates of a deeper black colour. This sufficiently shews, that the solution of Lead in the Must was stronger than that in the cyder.

It is a matter of no consequence, whether the Lead, the existence of which is proved, was applied to the cyder in its state of Must, or in that of a vinous liquor. However, as the Must afforded more considerable signs of impregnation than the cyder, it would seem probable that the lead was added to the Must; and that, as the acid, during the fermentation, is in a great measure converted into alcohol, a proportional quantity of lead will consequently be precipitated.

The same experiments were afterwards tried on several other specimens of Devonshire and of Herefordshire cyder. The result of them was constantly and uniformly the same as has been described.

It has been proposed by several Authors, to detect such adulterations of wines by means of the vitrolic or of the muriatic acid; which, by uniting with the lead, will make it precipitate. But it is ascertained by the experiments made by Professor Gaubius, that trials, made with the acids, are less conclusive than those which have been described.

Experiment V

In order to leave the matter entirely without doubt, an extract from 18 common quart bottles of Devonshire cyder (first strained through a cloth) which had been in my cellar more than three months, was prepared. This extract, being assayed with the black flux, a quantity of Lead, weighing four grains and an half, was found at the bottom of the crucible. These experiments were made in October 1766.

In the latter end of the last century, when the physicians of Germany (particularly Vicarious, Cockelius, and Brunnerus, whose dissertations of this subject may be found in the *Ephemerides Germanicæ*) had taken great pains to discover the true cause of the epidemic colic, which, to use the language of Brunnerus, (*Ephemerid. Germanic. Dec. 3. an. 4. Observat. 92*) "non minus aegrotantium viscera, quam medentum animos, torserat."[29] And when they had at last demonstrated, that this disorder was wholly to be referred to small acid wines, adulterated with litharge, there appeared a writer (a certain Seerup, a physician of Copenhagen) who endeavored to exhibit a specimen of his reading and ingenuity, by maintaining a bold paradox. This man, in very pompous language, and with an air of the greatest confidence, asserted in his *triumphus lithargyratorum*, that no danger was to be apprehended from wines in which litharge was dissolved; and that all the ill effects, supposed to have been derived from that cause, were really to be attributed to the austere acid of wine made of unripe grapes.

This opinion he endeavors to defend by the authority of Drawitzius, Sennertus, Van Helmont, Theodorus Zwinger, Boyle, Wepser, and several other Writers. He likewise quotes several authors, to shew the salutary effects produced in the human body by the internal use of lead; and insists, in the virtue of their testimony, that it had cured affections of the spleen, arising from an acid cause; the hypochondriacal disease; sudden inflammations; colics occasioned by the *Bilis æruginosa*; obstinate quartan fevers;[30] ulcerations of the lungs, as well as other parts; and the plague itself. He adduces other authorities to shew, that the *Aqua Saturni* had been of very great use in disorders occasioned by worms; that the *Spiritus Saturni* had cured the leprosy; that Paracelsus held it to be a specific remedy in madness; and that in the smallpox, and all other inflammations, it had been proved to be an efficacious medicine: That it was the great sudorific[31] medicine of Faber; and that it was Mynficht's secret for the cure of the phthisis,[32] and diseases of the spleen and colic; and that the great success, which had attended the practice of Petrus Matthias was ascribed to the use of *Saccharum Saturni*, and other preparations of lead: and lastly, that a constipation of the belly could not justly be attributed to *Saccharum Saturni*, since Antonius de Heide asserts, in his medicinal observations, that he cured that disorder by administering to his Patients five grains of that remedy, mixed with Crabs-eyes.

It is presumed that, the presence of lead in the Cyder of Devonshire being demonstrated, there is no one, at this time of day, likely to revive the argument of Seerup, and still insist on the deleterious quality of the acid: For a poison is discovered, which is experimentally known to be adequate to all those dreadful effects, so pathetically described by Dr. Huxham. It likewise presumed that no opinion, unsupported by facts and experience, (how respectable so ever the character of its author may be) will be admitted in evidence, when contrasted with the authority of a fact, which seems to be clearly demonstrated to our senses.

The general character of lead, and the preparations of lead, when given internally, has been, that they cool, incrassate, repel, absorb, and obtund acrimony. And it is very well known, that their real power has, in many instances, seemed to answer to such a general character; for there are scarcely any medicines, which produce their effects more immediately, or with greater certainty, in colliquative[33] sweats, in fluxes,[34] and in hemorrhages. But it is as well known, that the relief given, which for the most part, is only temporary, has been frequently followed by violent pain in the bowels, obstinate costiveness, suppression of urine, tremors, spasms, palsy, asthma, and suffocation. And altho', if we give credit to the testimony of credible writers, we must allow that Patients, of certain constitutions, may have taken these medicines with success, and with impunity; yet surely Physicians cannot be too cautious in avoiding the use of medicines, the effect of which, for aught that they can presume to ascertain, may be more formidable than the diseases to which they are opposed. That preparations of lead were formerly very fashionable medicines, we may judge from the oldest dispensatories, in which we find an almost infinite number of Magisteries, Elixers, and Balsams, which have that metal for their *basis*.

We are informed by Mr. De Haen, that the use of these medicines is much more common even now than is generally imagined. He thinks that the number of Patients, affected by the colic of Poitou, is immensely increased by such means. He mentions the *formula* of a medicine, compounded of *Saccharum Saturni*, of Cerusse,[35] and of water.[36] By this medicine taken cochleatim,[37] a Patient, he says, was cured of a gonorrhoea; but soon afterwards was seized with the most excruciating pain in his bowels, followed by a vomiting of his excrements. He adds, that this man, tho' he escaped death, even after three years, felt and lamented the reliques of that most dreadful cure. I could quote from my own experience more than one instance of cases, in several respects similar to this, which I have taken from Mr. De Haens *ratio medendi*.

What then can we think of the practice of the Chinese, who very frequently administer internally various preparations of Lead, to which they ascribe extraordinary virtues? The observation made on this subject by Mr. Malouin, in his *Chymie Medicinale,* seems judicious.

> "En réflé'chissant sur l'usage interieur que les Chinois font du Plomb, on est portè a croire que ces peuples sont differemment construits ou tempérés; ou que leur Plomb differe u nôtre."[38]

Dr. Huxham finds it a difficulty to account for the reason, "why the juice of apples in one year produces a costive belly, with violent colical pains, but in another, a loose belly with scarce any gripes attending." I have been informed by others, that small quantities of new cyder will frequently produce a *diarrhœa* in every year. But Citois observes, that the colic, which infested the inhabitants of the province of Poitou, was often attended,

> "per initia præsertim, cum alvi frequenti, sed non ita copioso, fluore, sæpius cum ejusdem adstrictione."[39]

M. Douzam, who writes on this disease in the *journal de medicine* for the month of October, 1760, affirms that

> "Il en est plusieurs, qui non seulement nont point éprouvé de constipation mais même qui se font plaints dun flux de ventre."[40]

The same thing is sometimes observed in the case of painters, and of other workmen employed about Lead. Some of them are cured by a spontaneous looseness of the belly. Mr. James Wilson, who (in the Essays and Observations physical and literary, published at Edinburgh, Vol. I. Art. 22.) gives an account of a disease, called by the miners Mill-reek, which all the inhabitants of Lead-Hills are subject to, but particularly those, whose daily business it is to melt down the Lead, observe, that, in the first stage of this disease, a diarrhoea sometimes makes a cure.

A question may be asked, "If the mischiefs occasioned by Cyder, particularly when it is new, arise from the poison of lead dissolved in it, how happens it, that all, who drink this liquor, do not suffer in proportion to the quantity of poison swallowed; and that some people, who have long accustomed themselves to it, have never experienced any of its bad effects?" This difficulty, (which is in its full force, whatever general cause be supposed) can only be solved by recurring to that inexplicable *idiosyncrasia*, in which there is so remarkable a difference among men. But it is likewise to be remembered, that the Physicians of Germany, who, in the latter end of the last, and in the beginning of the present century, wrote concerning wine adulterated by litharge, and the general effects of it, made the same observation. The words of Zeller are,

> "Multi tamen, imo innumeri ab eo laefi non fuerunt, utut ad ebrietatem ufque illud hauferint; alii leviter tantum."[41]

I shall only add, that it will not be easy to determine the exact quantity of lead dissolved by the acid of Cyder, unless an evaporation and an assay be made, as soon as the juice is expressed. For it seems probable, that, as it happened in the case of the adulterated wines of Germany (which, we are informed, after a few months, left that apparent, but pernicious improvement, which a fraud had given them) the Cyder may, in some time, deposit the greatest part of its poison. But that a very small quantity of this poison is capable of producing most terrible effects, is certain from what was formerly observed in Germany. For a calculation having been made, according to the method of adulterating wines which is described by Cockelius, a measure of wine, called the mensura *Wirtenburgica major,* (which Reiselius estimates at sixty-four ounces) scarcely contained one half of a grain of litharge.

May not I presume to hope, that the present discovery of a poison, which has for many years exerted its virulent effects on the inhabitants of Devonshire, incorporated *with their daily liquor, unobserved, and unsuspected, may be esteemed by those who have power, and who have opportunities to remove the source of so much mischief, to be an object worthy of their most serious attention? I have long lamented, that a County, which is distinguished by some peculiar blessings, should likewise be distinguished by a peculiar calamity, as it were in consequence of its fertility. The subject therefore having appeared to me important, I have spared no pains in this investigation; and I am insured of my reward in the consciousness of having endeavored to preserve my countrymen and fellow-creatures from one of the most dreadful diseases, incident to the human body.*

This essay will probably be hereafter published in a medicinal collection. Some copies of it are now printed, with a particular view of giving to the inhabitants of the county of Devon the earliest intimation of their danger; in order that they may take the proper steps to preserve their health, and to secure the value of their property.

FINIS

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CHAPTER 5

PERCIVAL POTT
(1714–1788)

Golden lads and girls all must,
As chimney sweepers, come to dust.
—William Shakespeare, *Cymbeline* IV, 1609–1610

If extirpation ever bids fair for the cure of a cancer, it seems to be in this case.
—Pott, *Cancer Scroti*, c. 1775

For avid readers of Sir Arthur Conan Doyle's Sherlock Holmes, the London fog was as much a part of life as the winter rains and the flowing of the Thames. The fog was the product of the numerous working fireplaces warming Victorian homes. A working fireplace was a key element in living through a London winter; it had been so for more than two centuries. Not surprisingly, a clean chimney was essential to safe and effective fireplace operation—hence a need for chimney sweeps. One of the earliest forms of occupational cancer to be recognized as such occurred among chimney sweeps, a discovery made by Sir Percival Pott in the eighteenth century.

Percival Pott was born in London on January 5, 1714, educated at a private school at Kent, and apprenticed to Edward Nourse at St. Bartholomew's Hospital from 1729 to 1736. Pott was admitted to the Barber-Surgeons' Company in 1736, and he worked his way up to senior surgeon and professor at St. Bartholomew's Hospital during 1765–1787. He had one of the most successful surgical practices in London.

In 1756, Pott fell from a horse and suffered an oblique compound fracture of the lower third of the tibia. Certain that riding in a carriage would exacerbate the injury, he refused to be moved until he could be carried off on a door. While immediate amputation was the usual treatment for this injury, Pott's limb was saved. In 1769, he wrote a classic description of this fracture (known as Pott's fracture) in a tome still in use by surgeons today.

Pott became a fellow of the Royal Society in 1764, an honorary fellow of the Royal College of Surgeons of Edinburgh in 1786, and an honorary member of the Royal College of Surgeons in Ireland in 1787. His publications include surgical tracts on ruptures, fistulae, hydrocele, head trauma, fractures, and curvature of the spine. Pott's most famous surgical tract is arguably one describing paraplegia of spinal tuberculosis as not related to spinal cord compression; rather, Pott suggested, it is associated with disorders in the lungs (Pott's paraplegia or Pott's disease). Yet those in the field of public health remember Pott not for his surgical work but for finding and reporting an association between exposure to soot and a high incidence of scrotal cancers in chimney sweeps.

Beginning in the seventeenth century, a master chimney sweep would apprentice boys as young as seven to climb into and scramble up chimneys, cleaning the inside of the flue with small brushes and using metal scrapers to remove the tar deposits left inside the hearth and stack. Child apprentices were usually orphans or from poor families. Their treatment and living conditions were harsh. Many slept on bags of soot and had little or no access to wash water or clean clothes. As a result of years of exposure to soot and grime, many developed cancer of the scrotum. They also choked and suffocated from dust inhalation, became stuck in narrow flues, or fell from climbing rotten stacks. Parliament finally outlawed the use of climbing boys in 1864, passing the Regulation of Chimney Sweepers Act with a penalty of £10 for offenders.

Yet the problem for chimney sweeps was not limited to immediate dangers. Pott continued to see ragged sores on the scrotums of many who worked in the trade. Some sweeps had their sores diagnosed as venereal disease, but Pott recognized the lesions as a form of skin cancer caused by soot being lodged in the rugae of the scrotum. Today, we honor Pott for this astute observation and for setting the stage for the development of occupational epidemiology.

Pott was a dedicated physician until the day he died. On December 21, 1788, he was apparently ill with a cold but determined to make a round of sick calls. He died of pneumonia the next day.

A Note on the Text

Cancer Scroti is the earliest account linking an occupational carcinogen with a specific type of cancer. Today, we know that the soot ground into the scrotal crevices of chimney sweeps is carcinogenic, containing 3,4-benzo(a)pyrene. Persons in occupations dealing with asphalt, carbon black, crude paraffin, pitch, soot, or tar are likely to be exposed to benzo(a)pyrene, as are those who work in processes that burn carbon products (coal or coke). The Occupational Safety and Health Administration (OSHA) regulates exposure to benzo(a)pyrene and recommends both engineering controls and personal protective equipment to limit exposures. Adverse health outcomes from this exposure include not only cancer but reproductive, respiratory, and dermal effects.

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Cancer Scroti
(c. 1775)

Ramazini has written a book *De Morbis Artificium*. The colic of Poictou is a well known distemper; and every body is acquainted with the disorders to which painters, plumbers, glaziers, and the workers in white lead, are liable: but there is a disease as peculiar to a certain set of people, which has not, at least to my knowledge, been publicly noticed; I mean the chimney-sweepers' cancer.

It is a disease which always makes its first attack on, and its first appearance in, the inferior part of the scrotum; where it produces a superficial, painful, ragged, ill-looking sore, with hard and rising edges: the trade call it the soot-wart. I never saw it under the age of puberty, which is, I suppose, one reason why it is generally taken, both by patient and surgeon, for venereal; and being treated with mercurials, is thereby soon and much exasperated. In no great length of time, it pervades the skin, dartos, and membranes of the scrotum, nod seizes the testicle, which it enlarges, hardens, and renders truly and thoroughly distempered; from whence it makes its way up the spermatic process into the abdomen, most frequently indurating and spoiling the inguinal glands: when arrived within the abdomen, it affects some of the viscera, and then very soon becomes painfully destructive.[1]

The fate of these people seems singularly hard; in their early infancy, they are most frequently treated with great brutality, and almost starved with cold and hunger; they are thrust up narrow, and sometimes hot chimneys, where they are bruised, burned, and almost suffocated; and when they get to puberty, become peculiarly liable to a most noisome, painful, and fatal disease.

Of this last circumstance there is not the least doubt, though perhaps it may not have been sufficiently attended to make it generally known. Other people have cancers of the same parts: and so have others, besides lead-workers the Poictou colic, and the consequent paralysis: but it is nevertheless a disease to which those persons are peculiarly liable; and so are chimney-sweepers to a cancer in the scrotum and testicles.

If there be any chance of putting a stop to, or preventing this mischief, it must be by the immediate removal of the part affected; I mean that part of the scrotum where the sore is; for if it be suffered to remain until the virus has seized the testicle, it is generally too late even for castration. I have many times made the experiment; but though the sores, after such operation, have, in some instances, healed kindly, and the patients have gone from the hospital seemingly well, yet, in the space of a few months, it has generally happened, that they have returned, either with the same disease in the other testicle, or in the glands of the groin, or with such wan complexions, such pale leaden countenances, such a total loss of strength, and such frequent and acute internal pains, as have sufficiently proved a diseased state of some of the viscera, and which have soon been followed by a painful death.

If extirpation ever bids fair for the cure of a cancer, it seems to be in this case; but then the operation should be immediate, and before the habit is tainted. The disease, in these people, seems to derive its origin from a lodgment of soot in the rugae of the scrotum, and at first not to be a disease of the habit. In other cases of a cancerous nature, in which the habit is too frequently concerned, [they] have not often so fair a prospect of success by the removal of the distempered part; and are obliged to be content with means, which I wish I could say were truly palliative: but here the subjects are young, in general in good health, at least at first; the disease brought on them by their occupation, and in all probability local; which last circumstance may, I think, be fairly presumed from its always seizing the same part: all this makes it (at first) a very different case from a cancer which appears in an elderly man, whose fluids are become acrimonious from time, as well as other causes; or from the same kind of complaint in women who have ceased to menstruate. But be this as it may, the scrotum is no vital organ, nor can the loss of a part of it ever [be] attended with any, the smallest degree of inconvenience; and if a life can be preserved by the removal of all that portion that is distempered, it will be a very good and easy composition; for when the disease has got head, it is rapid in its progress, painful in all its attacks, and most certainly destructive in its event.

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CHAPTER 6

EDWARD JENNER
(1749–1823)

Take the fluid of the pock on the udder of the cow . . . upon the point of a lancer, and lance with it the arms between the shoulders and elbows until the blood appears; then, mixing the fluid with the blood, the fever of the small-pox will be produced.

—DHANWANTARI (Hindu physician), 550

[T]he Practice of . . . preventing . . . Smallpox [by] Inoculation has [not] been introduced into our nation, where . . . so many . . . would give Great Sums, to have their Lives insur'd from the dangers of this dreadful Distemper. . . . I cannot but move that it be WARILY proceeded in.

—COTTON MATHER, 1721

BORN IN BERKELEY, GLOUCESTERSHIRE, ON MAY 17, 1749, Edward Jenner was the eighth of nine children raised by Reverend Stephen Jenner and his wife Sarah. Both of Edward's parents died by the time he was 5 years old, and he was brought up by his sister Mary and her husband Reverend Black. Jenner was an astute observer of nature from an early age. At 13 or 14, he was apprenticed to a local surgeon, Mr. Daniel Ludlow. In 1770, he moved to London to complete his medical training under John Hunter. Sir William Osler noted that Hunter imparted to the young Jenner Sir William Harvey's directive: "Don't think, try." Indeed, Hunter would remain in correspondence with Jenner when Edward returned to Berkeley in 1772 to build his medical practice as the local physician and surgeon.

Jenner was an avid researcher. He co-founded medical societies in Rodborough, Gloucestershire, and Alveston, near Bristol. A naturalist, he was elected a fellow of the Royal Society in 1788 for research on the cuckoo. In 1805, he was among the founding members of the organization that became the Royal Society of Medicine. In 1772, Jenner performed autopsies on the bodies of patients deceased from angina, observing that the large arteries around the heart of the deceased were lined with fatty and chalky deposits. He associated mitral stenosis with rheumatic heart disease and developed methods for purifying tartar emetic, a chemical used to treat parasitic diseases, thereby making the drug less toxic. Jenner is remembered, however, primarily for his work on smallpox.

In 1796, Sarah Nelmes, a dairymaid, sought treatment from Jenner for a rash on her hand. The rash was suggestive of smallpox, at the time a leading cause of death and disfigurement. Until then, the only means of preventing smallpox had been inoculation (variolation), that is, application of a piece of skin from a pock on an infected person onto the skin of someone who had not yet had smallpox. Inoculating persons against smallpox had been done for centuries in India, China, and Africa. Furthermore, there were experiments from the American colonies that proved variolation worked. When smallpox arrived in Boston in 1721, Cotton Mather heard his slave Onesimus explain that he had been inoculated in Africa and was therefore protected from the disease. Mather convinced a local physician, Zabdiel Boylston, to test the method, and Boylston did exactly that, on his only son and two of his slaves. All three contracted mild cases of smallpox, and all survived. The experiment caused a furor, as the local population believed the process would propagate an epidemic. After one year, 6 of the 244 persons Boylston inoculated against smallpox (2.5 percent) died of the disease, compared with 844 of 5,980 persons (14 percent) who contracted the disease naturally. Boylston traveled to London to present his findings to the Royal Society in 1726; no doubt Jenner was familiar with the Boston experiment.

Most of the time, a mild infection developed from variolation—and with it, lifelong immunity. However, there could be severe cases, as well. Controversy remained, with many questioning whether the mortality risk associated with variolation was sufficiently small compared to the mortality risk associated with developing the disease. Notable statistician Daniel Bernoulli examined this question and concluded that inoculation was beneficial in most circumstances. However, his report was not persuasive.

Until 1796, inoculation—with its risk of severe smallpox—remained the principal means of prevention of the disease. Jenner diagnosed Sarah Nelmes with cowpox rather than smallpox because one of her cows, Blossom, had recently had cowpox. Cowpox is usually a mild viral infection of cows, producing pocks on their udders. Milkmaids occasionally caught the disease from the cows; the disease was usually mild, with a short course and a good outcome. Sarah presented Jenner with the opportunity to test whether a cowpox infection could protect someone who had not yet had smallpox from the disease. Using material from a pock on Sarah's hand, Jenner scratched the skin of the eight-year-old son of his gardener, rubbing the material into the scratches. The child became mildly ill with cowpox but recovered within a week. Jenner then knew that cowpox was not only a zoonosis; it could be transferred from person to person. However, was the child protected from smallpox? He assessed this question by inoculating the child with smallpox. The disease did not manifest then, nor from a retest. Clearly, contracting cowpox protected against smallpox.

Jenner continued his experiments for several years and published his research in *An Inquiry Into The Causes And Effects Of The Variolae Vaccinae: A Disease Discovered In Some Of The Western Counties Of England, Particularly Gloucestershire, And Known By The Name Of The Cow-Pox*. He coined the term *vaccination* (from the Latin *vacca* for cow) for the new, safer procedure, and vaccination soon replaced variolation as the standard in public health. Louis Pasteur later applied the word *vaccination* to mean immunization against any disease, and that usage is standard today.

Jenner's discovery did not meet with a warm welcome in the medical community. The technique, however, spread quickly around the world. In the United States, Harvard Medical School professor Benjamin Waterhouse was an early adopter, vaccinating his own son in 1800. The British Parliament recognized Jenner's discovery by awarding him a £10,000 grant in 1802 and another for £20,000 in 1806. In 1803, a group of physicians banded together with Jenner to form the Royal Jennerian Society, an organization dedicated to promoting vaccination to eliminate smallpox. A few years later, that organization became the National Vaccine Establishment.

Toward the end of his life, Jenner practiced as a balneologist (a specialist in mineral bath therapies) at a spa in Cheltenham. After sustaining a mild stroke in 1820, he died of a recurrent one on January 26, 1823. He was buried near the altar in Berkeley church.

A Note on the Text

Inquiry reads as a case series of experiments, and those lucky enough to find an original or copy of the original will be impressed by the watercolors. As described above, Jenner—a naturalist—had a passion for birds as well as for medicine; he produced watercolors in the style of James Audubon. We remember him, however, as the one who put us on the path to the eradication of smallpox. The last case of naturally contracted smallpox occurred in 1976, when Ali Mao Maalin, a cook in Merca, Somalia, became the last person to naturally acquire the disease. The World Health Organization declared the disease eradicated in 1980.

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An Inquiry Into The Causes And Effects Of The Variolae Vaccinae: A Disease Discovered In Some Of The Western Counties Of England, Particularly Gloucestershire, And Known By the Name Of The Cow-Pox
(1798)

The deviation of man from the state in which he was originally placed by nature seems to have proved to him a prolific source of diseases. From the love of splendour, from the indulgences of luxury, and from his fondness for amusement he has familiarised himself with a great number of animals, which may not originally have been intended for his associates.

The wolf, disarmed of ferocity, is now pillowed in the lady's lap.[1] The cat, the little tiger of our island, whose natural home is the forest, is equally domesticated and caressed. The cow, the hog, the sheep, and the horse, are all, for a variety of purposes, brought under his care and dominion.

There is a disease to which the horse, from his state of domestication, is frequently subject. The farriers have called it *the Grease*. It is an inflammation and swelling in the heel, from which issues matter possessing properties of a very peculiar kind, which seems capable of generating a disease in the human body (after it has undergone the modification which I shall presently speak of), which bears so strong a resemblance to the small-pox that I think it highly probable it may be the source of the disease.

In this dairy country a great number of cows are kept, and the office of milking is performed indiscriminately by men and maid servants. One of the former having been appointed to apply dressings to the heels of a horse affected with *the Grease*, and not paying due attention to cleanliness, incautiously bears his part in milking the cows, with some particles of the infectious matter adhering to his fingers. When this is the case, it commonly happens that a disease is communicated to the cows, and from the cows to the dairymaids, which spreads through the farm until the most of the cattle and domestics feel its unpleasant consequences. This disease has obtained the name of the cow-pox. It appears on the nipples of the cows in the form of irregular pustules. At their first appearance they are commonly of a palish blue, or rather of a colour somewhat approaching to livid, and are surrounded by an erysipelatous inflammation. These pustules, unless a timely remedy be applied, frequently degenerate into phagedenic[2] ulcers, which prove extremely troublesome.[3] The animals become indisposed, and the secretion of milk is much lessened. Inflamed spots now begin to appear on different parts of the hands of the domestics employed in milking, and sometimes on the wrists, which quickly run on to suppuration, first assuming the appearance of the small vesications produced by a burn. Most commonly they appear about the joints of the fingers and at their extremities; but whatever parts are affected, if the situation will admit, these superficial suppurations put on a circular form, with their edges more elevated than their centre, and of a colour distantly approaching to blue. Absorption takes place, and tumours appear in each axilla. The system becomes affected—the pulse is quickened; and shiverings, succeeded by heat, with general lassitude and pains about the loins and limbs, with vomiting, come on. The head is painful, and the patient is now and then even affected with delirium. These symptoms, varying in their degrees of violence, generally continue from one day to three or four, leaving ulcerated sores about the hands, which, from the sensibility of the parts, are very troublesome, and commonly heal slowly, frequently becoming phagedenic, like those from whence they sprung. The lips, nostrils, eyelids, and other parts of the body are sometimes affected with sores; but these evidently arise from their being heedlessly rubbed or scratched with the patient's infected fingers. No eruptions on the skin have followed the decline of the feverish symptoms in any instance that has come under my inspection, one only excepted, and in this case a very few appeared on the arms: they were very minute, of a vivid red colour, and soon died away without advancing to maturation; so that I cannot determine whether they had any connection with the preceding symptoms.

Thus the disease makes its progress from the horse to the nipple of the cow, and from the cow to the human subject.

Morbid matter of various kinds, when absorbed into the system, may produce effects in some degree similar; but what renders the cow-pox virus so extremely singular is that the person who has been thus affected is forever after secure from the infection of the small-pox; neither exposure to the variolous effluvia, nor the insertion of the matter into the skin, producing this distemper.

In support of so extraordinary a fact, I shall lay before my reader a great number of instances.[4]

CASE I. Joseph Merret, now an under gardener to the Earl of Berkeley, lived as a servant with a farmer near this place in the year 1770, and occasionally assisted in milking his master's cows. Several horses belonging to the farm began to have sore heels, which Merret frequently attended. The cows soon became affected with the cow-pox, and soon after several sores appeared on his hands. Swellings and stiffness in each axilla followed, and he was so much indisposed for several days as to be incapable of pursuing his ordinary employment. Previously to the appearance of the distemper among the cows there was no fresh cow brought into the farm, nor any servant employed who was affected with the cow-pox. In April, 1795, a general inoculation taking place here, Merret was inoculated with his family; so that a period of twenty-five years had elapsed from his having the cow-pox to this time. However, though the variolous matter was repeatedly inserted into his arm, I found it impracticable to infect him with it; an efflorescence only, taking on an erysipelatous look about the centre, appearing on the skin near the punctured parts. During the whole time that his family had the small-pox, one of whom had it very full, he remained in the house with them, but received no injury from exposure to the contagion. It is necessary to observe that the utmost care was taken to ascertain, with the most scrupulous precision, that no one whose case is here adduced had gone through the small-pox previous to these attempts to produce that disease. Had these experiments been conducted in a large city, or in a populous neighbourhood, some doubts might have been entertained; but here, where population is thin, and where such an event as a person's having had the small-pox is always faithfully recorded, no risk of inaccuracy in this particular can arise.

CASE II. Sarah Portlock, of this place, was infected with the cow-pox when a servant at a farmer's in the neighbourhood, twenty-seven years ago.[5] In the year 1792, conceiving herself, from this circumstance, secure from the infection of the small-pox, she nursed one of her own children who had accidentally caught the disease, but no indisposition ensued. During the time she remained in the infected room, variolous matter was inserted into both her arms, but without any further effect than in the preceding case.

CASE III. John Phillips, a tradesman of this town, had the cow-pox at so early a period as nine years of age. At the age of sixty-two I inoculated him, and was very careful in selecting matter in its most active state. It was taken from the arm of a boy just before the commencement of the eruptive fever, and instantly inserted. It very speedily produced a sting-like feel in the part. An efflorescence appeared, which on the fourth day was rather extensive, and some degree of pain and stiffness were felt about the shoulder: but on the fifth day these symptoms began to disappear, and in a day or two after went entirely off, without producing any effect on the system.

CASE IV. Mary Barge, of Woodford, in this parish, was inoculated with variolous matter in the year 1791. An efflorescence of a palish red colour soon appeared about the parts where the matter was inserted, and spread itself rather extensively, but died away in a few days without producing any variolous symptoms.[6] She has since been repeatedly employed as a nurse to small-pox patients, without experiencing any ill consequences. This woman had the cow-pox when she lived in the service of a farmer in this parish thirty-one years before.

CASE V. Mrs. H——, a respectable gentlewoman of this town, had the cow-pox when very young. She received the infection in rather an uncommon manner: it was given by means of her handling some of the same utensils[7] which were in use among the servants of the family, who had the disease from milking infected cows. Her hands had many of the cow-pox sores upon them, and they were communicated to her nose, which became inflamed and very much swollen. Soon after this event Mrs. H—— was exposed to the contagion of the small-pox, where it was scarcely possible for her to have escaped, had she been susceptible of it, as she regularly attended a relative who had the disease in so violent a degree that it proved fatal to him. In the year 1778 the small-pox prevailed very much at Berkeley, and Mrs. H——, not feeling perfectly satisfied respecting her safety (no indisposition having followed her exposure to the small-pox), I inoculated her with active variolous matter. The same appearance followed as in the preceding cases—an efflorescence on the arm without any effect on the constitution.

CASE VI. It is a fact so well known among our dairy farmers that those who have had the small-pox either escape the cow-pox or are disposed to have it slightly, that as soon as the complaint shews itself among the cattle, assistants are procured, if possible, who are thus rendered less susceptible of it, otherwise the business of the farm could scarcely go forward. In the month of May, 1796, the cow-pox broke out at Mr. Baker's, a farmer who lives near this place. The disease was communicated by means of a cow which was purchased in an infected state at a neighbouring fair, and not one of the farmer's cows (consisting of thirty) which were at that time milked escaped the contagion. The family consisted of a man servant, two dairymaids, and a servant boy, who, with the farmer himself, were twice a day employed in milking the cattle. The whole of this family, except Sarah Wynne, one of the dairymaids, had gone through the small-pox. The consequence was that the farmer and the servant boy escaped the infection of the cow-pox entirely, and the servant man and one of the maid servants had each of them nothing more than a sore on one of their fingers, which produced no disorder in the system. But the other dairymaid, Sarah Wynne, who never had the small-pox, did not escape in so easy a manner. She caught the complaint from the cows, and was affected with the symptoms described on page 146 in so violent a degree that she was confined to her bed, and rendered incapable for several days of pursuing her ordinary vocations in the farm. March 28th, 1797, I inoculated this girl and carefully rubbed the variolous matter into two slight incisions made upon the left arm. A little inflammation appeared in the usual manner around the parts where the matter was inserted, but so early as the fifth day it vanished entirely without producing any effect on the system.

CASE VII. Although the preceding history pretty clearly evinces that the constitution is far less susceptible of the contagion of the cow-pox after it has felt that of the small-pox, and although in general, as I have observed, they who have had the small-pox, and are employed in milking cows which are infected with the cow-pox, either escape the disorder, or have sores on the hands without feeling any general indisposition, yet the animal economy is subject to some variation in this respect, which the following relation will point out: In the summer of the year 1796 the cow-pox appeared at the farm of Mr. Andrews, a considerable dairy adjoining to the town of Berkeley. It was communicated, as in the preceding instance, by an infected cow purchased at a fair in the neighbourhood. The family consisted of the farmer, his wife, two sons, a man and a maid servant; all of whom, except the farmer (who was fearful of the consequences), bore a part in milking the cows. The whole of them, exclusive of the man servant, had regularly gone through the small-pox; but in this case no one who milked the cows escaped the contagion. All of them had sores upon their hands, and some degree of general indisposition, preceded by pains and tumours in the axillae: but there was no comparison in the severity of the disease as it was felt by the servant man, who had escaped the small-pox, and by those of the family who had not, for, while he was confined to his bed, they were able, without much inconvenience, to follow their ordinary business. February the 13th, 1797, I availed myself of an opportunity of inoculating William Rodway, the servant man above alluded to. Variolous matter was inserted into both his arms: in the right, by means of superficial incisions, and into the left by slight punctures into the cutis. Both were perceptibly inflamed on the third day. After this the inflammation about the punctures soon died away, but a small appearance of erysipelas was manifest about the edges of the incisions till the eighth day, when a little uneasiness was felt for the space of half an hour in the right axilla. The inflammation then hastily disappeared without producing the most distant mark of affection of the system.

CASE VIII. Elizabeth Wynne, aged fifty-seven, lived as a servant with a neighbouring farmer thirty-eight years ago. She was then a dairymaid, and the cow-pox broke out among the cows. She caught the disease with the rest of the family, but, compared with them, had it in a very slight degree, one very small sore only breaking out on the little finger of her left hand, and scarcely any perceptible indisposition following it. As the malady had shewn itself in so slight a manner, and as it had taken place at so distant a period of her life, I was happy with the opportunity of trying the effects of variolous matter upon her constitution, and on the 28th of March, 1797, I inoculated her by making two superficial incisions on the left arm, on which the matter was cautiously rubbed. A little efflorescence soon appeared, and a tingling sensation was felt about the parts where the matter was inserted until the third day, when both began to subside, and so early as the fifth day it was evident that no indisposition would follow.

CASE IX. Although the cow-pox shields the constitution from the small-pox, and the small-pox proves a protection against its own future poison, yet it appears that the human body is again and again susceptible of the infectious matter of the cow-pox, as the following history will demonstrate. William Smith, of Pyrton in this parish, contracted this disease when he lived with a neighbouring farmer in the year 1780. One of the horses belonging to the farm had sore heels, and it fell to his lot to attend him. By these means the infection was carried to the cows, and from the cows it was communicated to Smith. On one of his hands were several ulcerated sores, and he was affected with such symptoms as have been before described. In the year 1791 the cow-pox broke out at another farm where he then lived as a servant, and he became affected with it a second time; and in the year 1794 he was so unfortunate as to catch it again. The disease was equally as severe the second and third time as it was on the first.[8] In the spring of the year 1795 he was twice inoculated, but no affection of the system could be produced from the variolous matter; and he has since associated with those who had the small-pox in its most contagious state without feeling any effect from it.

CASE X. Simon Nichols lived as a servant with Mr. Bromedge, a gentleman who resides on his own farm in this parish, in the year 1782. He was employed in applying dressings to the sore heels of one of his master's horses, and at the same time assisted in milking the cows. The cows became affected in consequence, but the disease did not shew itself on their nipples till several weeks after he had begun to dress the horse. He quitted Mr. Bromedge's service, and went to another farm without any sores upon him; but here his hands soon began to be affected in the common way, and he was much indisposed with the usual symptoms. Concealing the nature of the malady from Mr. Cole, his new master, and being there also employed in milking, the cow-pox was communicated to the cows. Some years afterward Nichols was employed in a farm where the small-pox broke out, when I inoculated him with several other patients, with whom he continued during the whole time of their confinement. His arm inflamed, but neither the inflammation nor his associating with the inoculated family produced the least effect upon his constitution.

CASE XI. William Stinchcomb was a fellow servant with Nichols at Mr. Bromedge's farm at the time the cattle had the cow-pox, and he was, unfortunately, infected by them. His left hand was very severely affected with several corroding ulcers, and a tumour of considerable size appeared in the axilla of that side. His right hand had only one small tumour upon it, and no tumour discovered itself in the corresponding axilla. In the year 1792 Stinchcomb was inoculated with variolous matter, but no consequences ensued beyond a little inflammation in the arm for a few days. A large party were inoculated at the same time, some of whom had the disease in a more violent degree than is commonly seen from inoculation. He purposely associated with them, but could not receive the small-pox. During the sickening of some of his companions their symptoms so strongly recalled to his mind his own state when sickening with the cow-pox that he very pertinently remarked their striking similarity.

CASE XII. The paupers of the village of Tortworth, in this county, were inoculated by Mr. Henry Jenner, Surgeon, of Berkeley, in the year 1795. Among them, eight patients presented themselves who had at different periods of their lives had the cow-pox. One of them, Hester Walkley, I attended with that disease when she lived in the service of a farmer in the same village in the year 1782; but neither this woman, nor any other of the patients who had gone through the cow-pox, received the variolous infection either from the arm or from mixing in the society of the other patients who were inoculated at the same time. This state of security proved a fortunate circumstance, as many of the poor women were at the same time in a state of pregnancy.

CASE XIII. One instance has occurred to me of the system being affected from the matter issuing from the heels of horses, and of its remaining afterwards unsusceptible of the variolous contagion; another, where the small-pox appeared obscurely; and a third, in which its complete existence was positively ascertained. First, Thomas Pearce is the son of a smith and farrier near to this place. He never had the cow-pox; but, in consequence of dressing horses with sore heels at his father's, when a lad, he had sores on his fingers which suppurated, and which occasioned a pretty severe indisposition. Six years afterwards I inserted variolous matter into his arm repeatedly, without being able to produce any thing more than slight inflammation, which appeared very soon after the matter was applied, and afterwards I exposed him to the contagion of the small-pox with as little effect.

CASE XIV. Secondly, Mr. James Cole, a farmer in this parish, had a disease from the same source as related in the preceding case, and some years after was inoculated with variolous matter. He had a little pain in the axilla and felt a slight indisposition for three or four hours. A few eruptions shewed themselves on the forehead, but they very soon disappeared without advancing to maturation.[9]

CASE XV. Although in the former instances the system seemed to be secured, or nearly so, from variolous infection, by the absorption of matter from the sores produced by the diseased heels of horses, yet the following case decisively proves that this cannot be entirely relied upon until a disease has been generated by the morbid matter from the horse on the nipple of the cow, and passed through that medium to the human subject. Mr. Abraham Riddiford, a farmer at Stone in this parish, in consequence of dressing a mare that had sore heels, was affected with very painful sores in both his hands, tumours in each axilla, and severe and general indisposition. A surgeon in the neighbourhood attended him, who knowing the similarity between the appearance of the sores upon his hands and those produced by the cow-pox, and being acquainted also with the effects of that disease on the human constitution, assured him that he never need to fear the infection of the small-pox; but this assertion proved fallacious, for, on being exposed to the infection upwards of twenty years afterwards, he caught the disease, which took its regular course in a very mild way. There certainly was a difference perceptible, although it is not easy to describe it, in the general appearance of the pustules from that which we commonly see. Other practitioners who visited the patient at my request agreed with me in this point, though there was no room left for suspicion as to the reality of the disease, as I inoculated some of his family from the pustules, who had the small-pox, with its usual appearances, in consequence.

CASE XVI. Sarah Nelmes, a dairymaid at a farmer's near this place, was infected with the cow-pox from her master's cows in May, 1796. She received the infection on a part of her hand which had been previously in a slight degree injured by a scratch from a thorn. A large pustulous sore and the usual symptoms accompanying the disease were produced in consequence. The pustule was so expressive of the true character of the cow-pox, as it commonly appears upon the hand, that I have given a representation of it in the annexed plate [Color plates in the original publication are not included in this version. Ed.]. The two small pustules on the wrists arose also from the application of the virus to some minute abrasions of the cuticle, but the livid tint, if they ever had any, was not conspicuous at the time I saw the patient. The pustule on the forefinger shews the disease in an earlier stage. It did not actually appear on the hand of this young woman, but was taken from that of another, and is annexed for the purpose of representing the malady after it has newly appeared.

CASE XVII. The more accurately to observe the progress of the infection I selected a healthy boy, about eight years old, for the purpose of inoculation for the cow-pox. The matter was taken from a sore on the hand of a dairymaid,[10] who was infected by her master's cows, and it was inserted, on the 14th of May, 1796, into the arm of the boy by means of two superficial incisions, barely penetrating the cutis, each about half an inch long. On the seventh day he complained of uneasiness in the axilla, and on the ninth he became a little chilly, lost his appetite, and had a slight headache. During the whole of this day he was perceptibly indisposed, and spent the night with some degree of restlessness, but on the day following he was perfectly well. The appearance of the incisions in their progress to a state of maturation were much the same as when produced in a similar manner by variolous matter. The only difference which I perceived was in the state of the limpid fluid arising from the action of the virus, which assumed rather a darker hue, and in that of the efflorescence spreading round the incisions, which had more of an erysipelatous look than we commonly perceive when variolous matter has been made use of in the same manner; but the whole died away (leaving on the inoculated parts scabs and subsequent eschars[11]) without giving me or my patient the least trouble. In order to ascertain whether the boy, after feeling so slight an affection of the system from the cow-pox virus, was secure from the contagion of the small-pox, he was inoculated the 1st of July following with variolous matter, immediately taken from a pustule. Several slight punctures and incisions were made on both his arms, and the matter was carefully inserted, but no disease followed. The same appearances were observable on the arms as we commonly see when a patient has had variolous matter applied, after having either the cow-pox or small-pox. Several months afterwards he was again inoculated with variolous matter, but no sensible effect was produced on the constitution. Here my researches were interrupted till the spring of the year 1798, when, from the wetness of the early part of the season, many of the farmers' horses in this neighbourhood were affected with sore heels, in consequence of which the cow-pox broke out among several of our dairies, which afforded me an opportunity of making further observations upon this curious disease. A mare, the property of a person who keeps a dairy in a neighbouring parish, began to have sore heels the latter end of the month of February, 1798, which were occasionally washed by the servant men of the farm, Thomas Virgoe, William Wherret, and William Haynes, who in consequence became affected with sores in their hands, followed by inflamed lymphatic glands in the arms and axillae, shiverings succeeded by heat, lassitude, and general pains in the limbs. A single paroxysm terminated the disease; for within twenty-four hours they were free from general indisposition, nothing remaining but the sores on their hands. Haynes and Virgoe, who had gone through the small-pox from inoculation, described their feelings as very similar to those which affected them on sickening with that malady. Wherret never had had the small-pox. Haynes was daily employed as one of the milkers at the farm, and the disease began to shew itself among the cows about ten days after he first assisted in washing the mare's heels. Their nipples became sore in the usual way, with bluish pustules; but as remedies were early applied, they did not ulcerate to any extent.

CASE XVIII. John Baker, a child of five years old, was inoculated March 16, 1798, with matter taken from a pustule on the hand of Thomas Virgoe, one of the servants who had been infected from the mare's heels. He became ill on the sixth day with symptoms similar to those excited by cow-pox matter. On the eighth day he was free from indisposition. There was some variation in the appearance of the pustule on the arm. Although it somewhat resembled a small-pox pustule, yet its similitude was not so conspicuous as when excited by matter from the nipple of the cow, or when the matter has passed from thence through the medium of the human subject—(See Plate, No. 2.). This experiment was made to ascertain the progress and subsequent effects of the disease when thus propagated. We have seen that the virus from the horse, when it proves infectious to the human subject, is not to be relied upon as rendering the system secure from variolous infection, but that the matter produced by it upon the nipple of the cow is perfectly so. Whether its passing from the horse through the human constitution, as in the present instance, will produce a similar effect, remains to be decided. This would now have been effected, but the boy was rendered unfit for inoculation from having felt the effects of a contagious fever in a workhouse soon after this experiment was made.

CASE XIX. William Summers, a child of five years and a half old, was inoculated the same day with Baker, with matter taken from the nipples of one of the infected cows, at the farm alluded to. He became indisposed on the sixth day, vomited once, and felt the usual slight symptoms till the eighth day, when he appeared perfectly well. The progress of the pustule, formed by the infection of the virus, was similar to that noticed in Case XVII, with this exception, its being free from the livid tint observed in that instance.

CASE XX. From William Summers the disease was transferred to William Pead, a boy of eight years old, who was inoculated March 28th. On the sixth day he complained of pain in the axilla, and on the seventh was affected with the common symptoms of a patient sickening with the small-pox from inoculation, which did not terminate till the third day after the seizure. So perfect was the similarity to the variolous fever that I was induced to examine the skin, conceiving there might have been some eruptions, but none appeared. The efflorescent blush around the part punctured in the boy's arm was so truly characteristic of that which appears on variolous inoculation that I have given a representation of it. The drawing was made when the pustule was beginning to die away and the areola retiring from the centre. (See Plate, No. 3.)

CASE XXI. April 5th: Several children and adults were inoculated from the arm of William Pead. The greater part of them sickened on the sixth day, and were well on the seventh, but in three of the number a secondary indisposition arose in consequence of an extensive erysipelatous inflammation which appeared on the inoculated arms. It seemed to arise from the state of the pustule, which spread out, accompanied with some degree of pain, to about half the diameter of a sixpence. One of these patients was an infant of half a year old. By the application of mercurial ointment to the inflamed parts (a treatment recommended under similar circumstances in the inoculated small-pox) the complaint subsided without giving much trouble.

Hannah Excell, an healthy girl of seven years old, and one of the patients above mentioned, received the infection from the insertion of the virus under the cuticle of the arm in three distinct points. The pustules which arose in consequence so much resembled, on the twelfth day, those appearing from the infection of variolous matter, that an experienced inoculator would scarcely have discovered a shade of difference at that period. Experience now tells me that almost the only variation which follows consists in the pustulous fluids remaining limpid nearly to the time of its total disappearance; and not, as in the direct small-pox, becoming purulent.—(See Plate, No. 4.)

CASE XXII. From the arm of this girl matter was taken and inserted April 12th into the arms of John Marklove, one year and a half old, Robert F. Jenner, eleven months old, Mary Pead, five years old, and Mary James, six years old. Among these, Robert F. Jenner did not receive the infection. The arms of the other three inflamed properly and began to affect the system in the usual manner; but being under some apprehensions from the preceding cases that a troublesome erysipelas might arise, I determined on making an experiment with the view of cutting off its source. Accordingly, after the patients had felt an indisposition of about twelve hours, I applied in two of these cases out of the three, on the vesicle formed by the virus, a little mild caustic, composed of equal parts of quick-lime and soap, and suffered it to remain on the part six hours.[12] It seemed to give the children but little uneasiness, and effectually answered my intention in preventing the appearance of erysipelas. Indeed, it seemed to do more, for in half an hour after its application the indisposition of the children ceased.[13] These precautions were perhaps unnecessary, as the arm of the third child, Mary Pead, which was suffered to take its common course, scabbed quickly, without any erysipelas.

CASE XXIII. From this child's arm matter was taken and transferred to that of J. Barge, a boy of seven years old. He sickened on the eighth day, went through the disease with the usual slight symptoms, and without any inflammation on the arm beyond the common efflorescence surrounding the pustule, an appearance so often seen in inoculated small-pox. After the many fruitless attempts to give the small-pox to those who had had the cow-pox, it did not appear necessary, nor was it convenient to me, to inoculate the whole of those who had been the subjects of these late trials; yet I thought it right to see the effects of variolous matter on some of them, particularly William Summers, the first of these patients who had been infected with matter taken from the cow. He was, therefore, inoculated with variolous matter from a fresh pustule; but, as in the preceding cases, the system did not feel the effects of it in the smallest degree. I had an opportunity also of having this boy and William Pead inoculated by my nephew, Mr. Henry Jenner, whose report to me is as follows: "I have inoculated Pead and Barge, two of the boys whom you lately infected with the cow-pox. On the second day the incisions were inflamed and there was a pale inflammatory stain around them. On the third day these appearances were still increasing and their arms itched considerably. On the fourth day the inflammation was evidently subsiding, and on the sixth day it was scarcely perceptible. No symptom of indisposition followed.

To convince myself that the variolous matter made use of was in a perfect state I at the same time inoculated a patient with some of it who never had gone through the cow-pox, and it produced the small-pox in the usual regular manner."

These experiments afforded me much satisfaction; they proved that the matter, in passing from one human subject to another, through five gradations, lost none of its original properties, J. Barge being the fifth who received the infection successively from William Summers, the boy to whom it was communicated from the cow.

I shall now conclude this inquiry with some general observations on the subject, and on some others which are interwoven with it.

Although I presume it may be unnecessary to produce further testimony in support of my assertion "that the cow-pox protects the human constitution from the infection of the small-pox," yet it affords me considerable satisfaction to say that Lord Somerville, the President of the Board of Agriculture, to whom this paper was shewn by Sir Joseph Banks, has found upon inquiry that the statements were confirmed by the concurring testimony of Mr. Dolland, a surgeon, who resides in a dairy country remote from this, in which these observations were made. With respect to the opinion adduced "that the source of the infection is a peculiar morbid matter arising in the horse," although I have not been able to prove it from actual experiments conducted immediately under my own eye, yet the evidence I have adduced appears sufficient to establish it.

They who are not in the habit of conducting experiments may not be aware of the coincidence of circumstances necessary for their being managed so as to prove perfectly decisive; nor how often men engaged in professional pursuits are liable to interruptions which disappoint them almost at the instant of their being accomplished: however, I feel no room for hesitation respecting the common origin of the disease, being well convinced that it never appears among the cows (except it can be traced to a cow introduced among the general herd which has been previously infected, or to an infected servant) unless they have been milked by some one who, at the same time, has the care of a horse affected with diseased heels.

The spring of the year 1797, which I intended particularly to have devoted to the completion of this investigation, proved, from its dryness, remarkably adverse to my wishes; for it frequently happens, while the farmers' horses are exposed to the cold rains which fall at that season, that their heels become diseased, and no cow-pox then appeared in the neighbourhood.

The active quality of the virus from the horses' heels is greatly increased after it has acted on the nipples of the cow, as it rarely happens that the horse affects his dresser with sores, and as rarely that a milkmaid escapes the infection when she milks infected cows. It is most active at the commencement of the disease, even before it has acquired a pus-like appearance; indeed, I am not confident whether this property in the matter does not entirely cease as soon as it is secreted in the form of pus. I am induced to think it does cease,[14] and that it is the thin, darkish-looking fluid only, oozing from the newly-formed cracks in the heels, similar to what sometimes appears from erysipelatous blisters, which gives the disease. Nor am I certain that the nipples of the cows are at all times in a state to receive the infection. The appearance of the disease in the spring and the early part of the summer, when they are disposed to be affected with spontaneous eruptions so much more frequently than at other seasons, induces me to think that the virus from the horse must be received upon them when they are in this state, in order to produce effects: experiments, however, must determine these points. But it is clear that when the cow-pox virus is once generated, that the cows cannot resist the contagion, in whatever state their nipples may chance to be, if they are milked with an infected hand.

Whether the matter, either from the cow or the horse, will affect the sound skin of the human body, I cannot positively determine; probably it will not, unless on those parts where the cuticle is extremely thin, as on the lips, for example. I have known an instance of a poor girl who produced an ulceration on her lip by frequently holding her finger to her mouth to cool the raging of a cow-pox sore by blowing upon it. The hands of the farmers' servants here, from the nature of their employments, are constantly exposed to those injuries which occasion abrasions of the cuticle, to punctures from thorns, and such like accidents; so that they are always in a state to feel the consequence of exposure to infectious matter.

It is singular to observe that the cow-pox virus, although it renders the constitution unsusceptible of the variolous, should nevertheless, leave it unchanged with respect to its own action. I have already produced an instance[15] to point out this, and shall now corroborate it with another.

Elizabeth Wynne, who had the cow-pox in the year 1759, was inoculated with variolous matter, without effect, in the year 1797, and again caught the cow-pox in the year 1798. When I saw her, which was on the eighth day after she received the infection, I found her affected with general lassitude, shiverings, alternating with heat, coldness of the extremities, and a quick and irregular pulse. These symptoms were preceded by a pain in the axilla. On her hand was one large pustulous sore, which resembled that delineated in Plate No. 1.

It is curious also to observe that the virus, which with respect to its effects is undetermined and uncertain previously to its passing from the horse through the medium of the cow, should then not only become more active, but should invariably and completely possess those specific properties which induce in the human constitution symptoms similar to those of the variolous fever, and effect in it that peculiar change which for ever renders it unsusceptible of the variolous contagion.

May it not then be reasonably conjectured that the source of the small-pox is morbid matter of a peculiar kind, generated by a disease in the horse, and that accidental circumstances may have again and again arisen, still working new changes upon it until it has acquired the contagious and malignant form under which we now commonly see it making its devastations amongst us? And, from a consideration of the change which the infectious matter undergoes from producing a disease on the cow, may we not conceive that many contagious diseases, now prevalent among us, may owe their present appearance not to a simple, but to a compound, origin? For example, is it difficult to imagine that the measles, the scarlet fever, and the ulcerous sore throat with a spotted skin have all sprung from the same source, assuming some variety in their forms according to the nature of their new combinations? The same question will apply respecting the origin of many other contagious diseases which bear a strong analogy to each other.

There are certainly more forms than one, without considering the common variation between the confluent and distinct, in which the small-pox appears in what is called the natural way. About seven years ago a species of small-pox spread through many of the towns and villages of this part of Gloucestershire: it was of so mild a nature that a fatal instance was scarcely ever heard of, and consequently so little dreaded by the lower orders of the community that they scrupled not to hold the same intercourse with each other as if no infectious disease had been present among them. I never saw nor heard of an instance of its being confluent. The most accurate manner, perhaps, in which I can convey an idea of it is by saying that had fifty individuals been taken promiscuously and infected by exposure to this contagion, they would have had as mild and light a disease as if they had been inoculated with variolous matter in the usual way. The harmless manner in which it shewed itself could not arise from any peculiarity either in the season or the weather, for I watched its progress upwards of a year without perceiving any variation in its general appearance. I consider it then as a variety of the Small-pox.[16]

In some of the preceding cases I have noticed the attention that was paid to the state of the variolous matter previous to the experiment of inserting it into the arms of those who had gone through the cow-pox. This I conceived to be of great importance in conducting these experiments, and, were it always properly attended to by those who inoculate for the small-pox, it might prevent much subsequent mischief and confusion. With the view of enforcing so necessary a precaution I shall take the liberty of digressing so far as to point out some unpleasant facts relative to mismanagement in this particular, which have fallen under my own observation.

A medical gentleman (now no more), who for many years inoculated in this neighbourhood, frequently preserved the variolous matter intended for his use on a piece of lint or cotton, which, in its fluid state, was put into a vial, corked, and conveyed into a warm pocket; a situation certainly favourable for speedily producing putrefaction in it. In this state (not unfrequently after it had been taken several days from the pustules) it was inserted into the arms of his patients, and brought on inflammation of the incised parts, swellings of the axillary glands, fever, and sometimes eruptions. But what was this disease? Certainly not the small-pox; for the matter having from putrefaction lost or suffered a derangement in its specific properties, was no longer capable of producing that malady, those who had been inoculated in this manner being as much subject to the contagion of the small-pox as if they had never been under the influence of this artificial disease; and many, unfortunately, fell victims to it, who thought themselves in perfect security. The same unfortunate circumstance of giving a disease, supposed to be the small-pox, with inefficacious variolous matter, having occurred under the direction of some other practitioners within my knowledge, and probably from the same incautious method of securing the variolous matter, I avail myself of this opportunity of mentioning what I conceive to be of great importance; and, as a further cautionary hint, I shall again digress so far as to add another observation on the subject of inoculation.

Whether it be yet ascertained by experiment that the quantity of variolous matter inserted into the skin makes any difference with respect to the subsequent mildness or violence of the disease, I know not; but I have the strongest reason for supposing that if either the punctures or incisions be made so deep as to go through it and wound the adipose membrane, that the risk of bringing on a violent disease is greatly increased. I have known an inoculator whose practice was to cut deep enough (to use his own expression) to "see a bit of fat," and there to lodge the matter. The great number of bad cases, independent of inflammations and abscesses on the arms, and the fatality which attended this practice, was almost inconceivable; and I cannot account for it on any other principle than that of the matter being placed in this situation instead of the skin.

It was the practice of another, whom I well remember, to pinch up a small portion of the skin on the arms of his patients and to pass through it a needle, with a thread attached to it previously dipped in variolous matter. The thread was lodged in the perforated part, and consequently left in contact with the cellular membrane. This practice was attended with the same ill success as the former. Although it is very improbable that any one would now inoculate in this rude way by design, yet these observations may tend to place a double guard over the lancet, when infants, whose skins are comparatively so very thin, fall under the care of the inoculator.

A very respectable friend of mine, Dr. Hardwicke, of Sodbury in this county, inoculated great numbers of patients previous to the introduction of the more modern method by Sutton, and with such success that a fatal instance occurred as rarely as since that method has been adopted. It was the doctor's practice to make as slight an incision as possible *upon* the skin, and there to lodge a thread saturated with the variolous matter. When his patients became indisposed, agreeably to the custom then prevailing, they were directed to go to bed and were kept moderately warm. Is it not probable then that the success of the modern practice may depend more upon the method of invariably depositing the virus in or upon the skin, than on the subsequent treatment of the disease?

I do not mean to insinuate that exposure to cool air, and suffering the patient to drink cold water when hot and thirsty, may not moderate the eruptive symptoms and lessen the number of pustules; yet, to repeat my former observation, I cannot account for the uninterrupted success, or nearly so, of one practitioner, and the wretched state of the patients under the care of another, where, in both instances, the general treatment did not differ essentially, without conceiving it to arise from the different modes of inserting the matter for the purpose of producing the disease. As it is not the identical matter inserted which is absorbed into the constitution, but that which is, by some peculiar process in the animal economy, generated by it, is it not probable that different parts of the human body may prepare or modify the virus differently? Although the skin, for example, adipose membrane, or mucous membranes are all capable of producing the variolous virus by the stimulus given by the particles originally deposited upon them, yet I am induced to conceive that each of these parts is capable of producing some variation in the qualities of the matter previous to its affecting the constitution. What else can constitute the difference between the small-pox when communicated casually or in what has been termed the natural way, or when brought on artificially through the medium of the skin?

After all, are the variolous particles, possessing their true specific and contagious principles, ever taken up and conveyed by the lymphatics unchanged into the blood vessels? I imagine not. Were this the case, should we not find the blood sufficiently loaded with them in some stages of the small-pox to communicate the disease by inserting it under the cuticle, or by spreading it on the surface of an ulcer? Yet experiments have determined the impracticability of its being given in this way; although it has been proved that variolous matter, when much diluted with water and applied to the skin in the usual manner, will produce the disease. But it would be digressing beyond a proper boundary to go minutely into this subject here.

At what period the cow-pox was first noticed here is not upon record. Our oldest farmers were not unacquainted with it in their earliest days, when it appeared among their farms without any deviation from the phenomena which it now exhibits. Its connection with the small-pox seems to have been unknown to them. Probably the general introduction of inoculation first occasioned the discovery.

Its rise in this country may not have been of very remote date, as the practice of milking cows might formerly have been in the hands of women only; which I believe is the case now in some other dairy countries, and, consequently, that the cows might not in former times have been exposed to the contagious matter brought by the men servants from the heels of horses.[17] Indeed, a knowledge of the source of the infection is new in the minds of most of the farmers in this neighbourhood, but it has at length produced good consequences; and it seems probable, from the precautions they are now disposed to adopt, that the appearance of the cow-pox here may either be entirely extinguished or become extremely rare.

Should it be asked whether this investigation is a matter of mere curiosity, or whether it tends to any beneficial purpose, I should answer that, notwithstanding the happy effects of inoculation, with all the improvements which the practice has received since its first introduction into this country, it not very unfrequently produces deformity of the skin, and sometimes, under the best management, proves fatal.

These circumstances must naturally create in every instance some degree of painful solicitude for its consequences. But as I have never known fatal effects arise from the cow-pox, even when impressed in the most unfavourable manner, producing extensive inflammations and suppurations on the hands; and as it clearly appears that this disease leaves the constitution in a state of perfect security from the infection of the small-pox, may we not infer that a mode of inoculation may be introduced preferable to that at present adopted, especially among those families which, from previous circumstances, we may judge to be predisposed to have the disease unfavourably? It is an excess in the number of pustules which we chiefly dread in the small-pox; but in the cow-pox no pustules appear, nor does it seem possible for the contagious matter to produce the disease from effluvia, or by any other means than contact, and that probably not simply between the virus and the cuticle; so that a single individual in a family might at any time receive it without the risk of infecting the rest or of spreading a distemper that fills a country with terror.

Several instances have come under my observation which justify the assertion that the disease cannot be propagated by effluvia. The first boy whom I inoculated with the matter of cow-pox slept in a bed, while the experiment was going forward, with two children who never had gone through either that disease or the small-pox, without infecting either of them.

A young woman who had the cow-pox to a great extent, several sores which maturated having appeared on the hands and wrists, slept in the same bed with a fellow-dairymaid who never had been infected with either the cow-pox or the small-pox, but no indisposition followed.

Another instance has occurred of a young woman on whose hands were several large suppurations from the cow-pox, who was at the same time a daily nurse to an infant, but the complaint was not communicated to the child.

In some other points of view the inoculation of this disease appears preferable to the variolous inoculation.

In constitutions predisposed to scrophula,[18] how frequently we see the inoculated small-pox rouse into activity that distressful malady! This circumstance does not seem to depend on the manner in which the distemper has shewn itself, for it has as frequently happened among those who have had it mildly as when it has appeared in the contrary way.

There are many who, from some peculiarity in the habit, resist the common effects of variolous matter inserted into the skin, and who are in consequence haunted through life with the distressing idea of being insecure from subsequent infection. A ready mode of dissipating anxiety originating from such a cause must now appear obvious. And, as we have seen that the constitution may at any time be made to feel the febrile attack of cow-pox, might it not, in many chronic diseases, be introduced into the system, with the probability of affording relief, upon well-known physiological principles?

Although I say the system may at any time be made to feel the febrile attack of cow-pox, yet I have a single instance before me where the virus acted locally only, but it is not in the least probable that the same person would resist the action both of the cow-pox virus and the variolous.

Elizabeth Sarsenet lived as a dairymaid at Newpark farm, in this parish. All the cows and the servants employed in milking had the cow-pox; but this woman, though she had several sores upon her fingers, felt no tumours in the axillae, nor any general indisposition. On being afterwards casually exposed to variolous infection, she had the small-pox in a mild way.—Hannah Pick, another of the dairymaids who was a fellow-servant with Elizabeth Sarsenet when the distemper broke out at the farm, was, at the same time, infected; but this young woman had not only sores upon her hands, but felt herself also much indisposed for a day or two. After this, I made several attempts to give her the small-pox by inoculation, but they all proved fruitless. From the former case then we see that the animal economy is subject to the same laws in one disease as the other.

The following case, which has very lately occurred, renders it highly probable that not only the heels of the horse, but other parts of the body of that animal, are capable of generating the virus which produces the cow-pox.

An extensive inflammation of the erysipelatous kind appeared without any apparent cause upon the upper part of the thigh of a sucking colt, the property of Mr. Millet, a farmer at Rockhampton, a village near Berkeley. The inflammation continued several weeks, and at length terminated in the formation of three or four small abscesses. The inflamed parts were fomented, and dressings were applied by some of the same persons who were employed in milking the cows. The number of cows milked was twenty-four, and the whole of them had the cow-pox. The milkers, consisting of the farmer's wife, a man and a maid servant, were infected by the cows. The man-servant had previously gone through the small-pox, and felt but little of the cow-pox. The servant maid had some years before been infected with the cow-pox, and she also felt it now in a slight degree; but the farmer's wife, who never had gone through either of the diseases, felt its effects very severely.

That the disease produced upon the cows by the colt and from thence conveyed to those who milked them was the true and not the spurious cow-pox,[19] there can be scarcely any room for suspicion; yet it would have been more completely satisfactory had the effects of variolous matter been ascertained on the farmer's wife, but there was a peculiarity in her situation which prevented my making the experiment.

Thus far have I proceeded in an inquiry founded, as it must appear, on the basis of experiment; in which, however, conjecture has been occasionally admitted in order to present to persons well situated for such discussions, objects for a more minute investigation. In the mean time I shall myself continue to prosecute this inquiry, encouraged by the hope of its becoming essentially beneficial to mankind.

FINIS

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CHAPTER 7

PETER LUDWIG PANUM
(1820–1885)

Then came the measles. During two long weeks Tom lay a prisoner, dead to the world and its happenings.

— Mark Twain, *Huckleberry Finn*, 1885

Best known for his contributions toward the establishment of modern physiology, Peter Ludwig Panum was born in Denmark on December 19, 1820. His father, a regimental surgeon, died when Peter was 16. He matriculated to the University of Kiel but completed his studies at the University of Copenhagen. Lacking family as means of support, Panum took a job as a schoolteacher. His teaching abilities were strong, and he was soon in great demand as an instructor. He also wrote, completing an introductory textbook on the scientific method. Upon gaining sufficient funds, he applied, was accepted, and completed medical school in Copenhagen.

During his medical studies, in 1846, Panum was chosen by the government to investigate a measles epidemic on the Faroe Islands. His publication from that epidemic, *Observations Made During the Measles Epidemic on the Faroe Islands in the Year 1846*, is considered an epidemiologic classic. It was traditional in the 1800s for medical students to complete a thesis. Panum's thesis, however, was nothing short of spectacular. Indeed, much of what we know about measles today can be traced to this work.

After Panum's Faroe Islands' experience, he practiced first at the Almindeligt Hospital, then as a naval physician, and then as a physician in Bandholm during a cholera epidemic in 1850. These experiences convinced him his talents were better applied in a research capacity rather than in treating patients. Accordingly, Panum finished a doctoral thesis on fibrin in 1851 and went to Wurzburg, Germany, where he befriended Rudolph Virchow, a Prussian scientist who focused on cellular pathology. From 1852 to 1853, Panum studied "experimental medicine" (now known as physiology) with Claude Bernard in Paris. While working with Bernard, Panum discovered the role of endotoxins, the finding for which he is most remembered.

Panum secured a position as professor at the University of Kiel, Germany, in

1855, characterizing the "putrescent poison" (thought to be the cause of blood poisoning), now identified as endotoxins. He established a physiology laboratory at Kiel and pursued new knowledge essential for the development of blood transfusions. However, Panum found anti-Danish sentiment in Kiel too stressful, and in 1862 he relocated to the University of Copenhagen, where he remained for the remainder of his career.

Panum died on May 2, 1885. The university immediately appointed his assistant, Christian Bohr (father of Niels Bohr, atomic structure and radiation scientist who won the Nobel Prize in 1922), to serve as director of Panum's research laboratory.

A Note on the Text

Panum's publication on the measles epidemic on the Faroe Islands remains a landmark in epidemiology. The effort put forth to document the cases, their contacts, and the spread of the disease was arduous, indeed. For more than a century, until the development of a measles vaccine in the 1960s, little new information was discerned about the epidemiology of the disease that Panum had not observed and reported during his Faroe Islands experience. The communicability of the disease, its incubation period, the degree to which immunity persisted, and other epidemiologic characteristics were analyzed and stated in an unambiguous manner. Indeed, the most telling aspect of the selected reading is the literary skill displayed by Panum in describing events during the epidemic.

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Observations Made During the Epidemic of Measles on the Faroe Islands in the Year 1846
(1847, Abridged)

I. When a physician is called to work in a place where climatic and dietary conditions are different from those to which he has been accustomed, his first problem is to study the hygienic factors which affect the state of health of the inhabitants. It is, in fact, these hygienic conditions which contribute towards the development and frequency of some diseases and the exclusion or rarity of others, and which more or less modify the symptoms of every disease; it is, indeed, these conditions that constitute the basis of the geography of disease, the special study of which subject will soon, perhaps, elevate it to the status of an independent science.

Since the outbreak of measles provided the occasion for my journey to the Faroe Islands, it was natural that I should direct my attention at once to the influence which the extremely peculiar hygienic conditions of the islands exerted upon this disease, and vice versa. Moreover, because during my sojourn of almost five months on the Faroes, I repeatedly traveled over the greater part of the islands, I was therefore in a position to make a great many observations in regard to the influence of their special hygienic conditions upon the state of health in general, as well as upon the frequency and development of the prevailing diseases. To be able to give a complete nosography of the Faroes, a stay of several years would be necessary; what I here communicate consists only of some nosographic points and fragments, which may, perhaps, be interesting merely because so little is known about conditions on the Faroes in this respect. . . .

[Fifty pages on the history, geography, and people of the Faroe Islands have been deleted here. Ed.]

The influence which the epidemic of measles of 1846 exerted on the mortality rates of the Faroes may serve as an example to illustrate the tendency of epidemics as a whole to decimate the population of a country. Of course, measles is not wont under ordinary conditions to menace any but children, but on the Faroes it evidently attacked almost the entire population without respect to age; and the epidemics in the aggregate, which prevail in other countries but partially spare the Faroes, also threaten the entire population, without respect to age. I believe that I have established that the most essential cause of the favorable rates of mortality on the Faroes may be looked for in the freedom of these islands, because of their situation as well as their isolated condition as regards commerce from many diseases which in other places, in Denmark, for instance, very considerably increase the mortality. It is obvious, then, that prophylactic measures against the introduction and spread of foreign diseases are of very great importance in such places, where they can be put into execution, as, for example, on the Faroes; whereas they are of no importance where they are rendered impracticable by a great conflux of people and by other conditions, as in Copenhagen. Here, therefore, an edict of quarantine against measles would seem ludicrous, but the Faroe Islands would probably not have lost nearly 100 inhabitants if an edict directed against the introduction of measles had not been removed some years ago.

II. Measles is a disease so generally familiar and so almost trivial as to warrant the supposition that observations in regard to it could offer nothing new, except in special cases with more or less rare complications. It is not, however, my intention here to go into details which are of only more or less partial interest, but to present sonic observations with regard to the nature of the contagiousness of measles, which peculiarly favorable circumstances rendered it possible for me to make, and which I believe merit some attention.

As to the *length of the incubation period,* accurate and satisfactory observations have hitherto been lacking, as far as I know, since some authors regard it as eight days, others as from ten to fourteen days, and others again assume no definite stadium contagii latentis. This is not strange, however, inasmuch as observations in regard to the subject could not well be made where a very lively intercourse goes on among the people, and where each individual comes into contact with a large number of other individuals, each of whom may be carrying the material of infection with him. Here in Copenhagen, for instance, it can very rarely be said of a measles patient that he was exposed to infection only once, on this or that day; for it can hardly ever be proved that he was not in anyways exposed earlier or later, without knowing it, to the influence of the contagion of measles. To be able to arrive at some definite result in reference to this question would call for special circumstances which might render it possible to make accurate observations, and these circumstances were offered on the Faroe Islands. The isolated situation of the villages, and their limited intercourse with each other, made it possible in many, in fact in most cases, to ascertain where and when the person who first fell ill had been exposed to the infection, and to prove that the contagion could not have affected him either before or after the day stated.

The first person on the Faroes who took measles was a cabinetmaker, now living in Thorshavn.[1] He left Copenhagen on the 20th of March and reached Thorshavn on the 28th; on the journey he felt quite well, but was attacked by measles early in April, on what day he did not know. Shortly before his departure he had visited some measles patients in Copenhagen. About fourteen days later his two nearest associates were attacked. These facts, although inaccurately observed to be sure, which were related to me before my departure from Thorshavn, induced me to give attention in my travels about the islands to the length of the stage of incubation.

The first village to which I came (on July 2nd) on my rounds was Tjörnevig, on Nordströmø, where eighty of the 100 inhabitants were down with measles. On the 4th of June a boat with ten men from Tjörnevig had taken part in a catch of grind at Vestmannhavn; and on the 18th of June, precisely the fourteenth day following, the measles exanthem had broken out on all ten men, after they had been feeling ill from two to four days, and had been suffering with cough and smarting of the eyes. The ten men mentioned had not been together at all except at the grind-catch referred to, and none of them had been at any place where they could have happened to be exposed in the remotest way to the infection, which they dreaded and shunned. In Vestmannhavn, on the other hand, they had not only been in contact with many men who had recently got up after measles (perhaps some of them still florid with the exanthem), but had also been staying for sometime in houses where persons had to go to bed on the next day with an eruption of the measles exanthem. From twelve to sixteen days after these ten men had taken measles (counting from the appearance of the rash), the exanthem broke out on nearly all the other inhabitants, except some few individuals, who were not attacked until twelve to sixteen days after the first general outbreak.

These facts might suggest that the contagion of measles produces no visible effect for quite a long time, usually ten to twelve days, after its reception into the organism, since the catarrhal prodromal stage began just after this lapse of time, and the exanthem first appeared on the fourteenth day after the reception of the infective matter. If this supposition were confirmed, then the observation that the second and third general outbreaks ensued each after about fourteen days' interim would make it probable that measles is most infectious during the stage of eruption and efflorescence, and not, as generally supposed, during that of desquamation.

In order to investigate as to whether or not these suppositions were well-founded, I decided to undertake in each village, to which I came, a brief inquiry, as exact as possible, in regard to the origin, mode of introduction and of spread of the disease. In this manner I obtained, for fifty-two villages, the names of the persons who first took measles, the circumstances and dates of their exposure to infection, the dates on which the exanthem appeared on them, and the time that elapsed thereafter before other residents broke out with the exanthem. It would become too tedious to review this for every single village, especially since I found the suppositions set forth above confirmed everywhere, and I did not encounter any instances to prove that there were exceptions to the rule. I shall, therefore, present here only some eases by which these conclusions were substantiated in most remarkable fashion.

In Velbertstad, on Sydströmø, I obtained statements which contradicted my assumption of a stage of incubation of a definite length, inasmuch as there appeared to have been, in the case of a certain patient, only ten days between the time on which the patient was exposed to the infection and the day on which the exanthema appeared. Since it was a very reliable man who stated this to me, and the patient concerned was his own wife, I thought I had found here an exception to the rule. But on Olai (July 29th) the same man sent me a message by his nephew, Pastor Djurhuus, to the effect that his statement had not been correct, but that it was exactly fourteen days, instead of ten, that had intervened between the time that his wife had been exposed to the infection and the day on which she broke out with the exanthem. Shortly before my arrival the man had lost at the same time his beloved wife and a sister, and his grief had distracted him.

The other case in which I thought I had found an exception to the rule was in Hattervig, on Fuglø. A young man, the first person who had developed measles there, declared to me that he had not been outside Hattervig except on Whitmonday (June 1st) when, together with another man, he was in Arnefjord, on Bordø where at that time measles had not broken out, but where, as he had learned later, a man had developed the exanthem on the 3rd of June, and two others on the 8th.[2] The first young man asserted that in his case the exanthem had appeared on the 11th of June, but in his companion's not until the 14th. Although I explained to him that it was of great importance to other people that he should tell me the truth, and that there was no question of any responsibility for him, he would not admit that he had been exposed any earlier to the infection. But in the evening, when I was sitting in the smoke-room, attired in Faroese clothes, he came to me and begged my pardon because he had not recollected correctly; the fact was that he had been also in Klaksvig, on the 30th of May, and being in an intoxicated condition, had been in several houses where there was measles. The procedure that I had followed, somewhat resembling an examination, had made the young man from that isolated Fuglø uneasy, and had induced him to conceal the truth.

In Selletraed, on Østerø, I was told that a young man had been infected on June 4th at the grind haul in Vestmannhavn, and that on June 9th he had broken out with the exanthem, and that his younger brother and other folk in the village had been infected by him, and had broken out with the exanthem on June 17th. I asked for the almanac, and inquired where the older brother had been on the 26th of May (fourteen days before the exanthem broke out on him). They told me that on that very day he had been in Nord-Øre, where measles was prevailing, and that on the way home he had spent the night of the same day in Sydre-Göthe, and had slept in the bed with the servant-man of P. Johnson's widow; but that in Nord-Øre he had not been in any house, and there was no measles in Sydre-Göthe at that time. By looking at my notes afterwards, I found that the servant-man mentioned was the first person who took measles in Sydre-Göthe, and that the exanthem had spread over his whole body a few days later. Then I learned that only those folk in the village who had broken out with the measles exanthem at the same time as the younger brother had been along with the brothers at the grind-catch at Vestmannhavn. It was now clear to me that the elder brother had been infected in Göthe (or possibly in Nord-Øre), and the younger, together with the others, in Vestmannhavn.

In Fuglefjord, on Østerø, on account of my observations, I acquired the reputation of being able to prophesy. On my first arrival there, the daughter of Farmer J. Hansen, churchwarden, had recently had measles, but had then got up, and, except for a slight cough, was almost entirely well. All the other nine persons in the house were feeling well in every respect and expressed the hope that they would escape the disease. I inquired as to what day the exanthem had appeared on the daughter, asked for the almanac, and pointed to the fourteenth day after that on which the exanthem had been noticed on the daughter, with the remark that they should make a black line under that date, for I feared that on it measles would show itself on others in the house; if this did not happen on that day, they might perhaps have some hope of being exempt. As it turned out I was summoned to Fuglefjord again ten days later and was met with the outcry: "What he said was correct! On the day he pointed out the measles broke out, with its red spots, on all nine."

Having on my first round found my suppositions verified in the thirteen villages which I inspected, I felt it my duty to impart my findings to my colleagues, Mr. Regenburg, Provincial Surgeon in Thorshavn, and Candidate Manicus, who was staying on Suderø. Both have since told me that they, too, have found these observations confirmed in their practice, without feeling assured, however, that there were no exceptions to the rule. The young medical practitioner, Candidate Nolsøe, likewise assured me that he had everywhere found the observations cited confirmed in his practice, except at Skaalevig, on Sandø, where the general rule did not hold good at all, and where it was impossible to detect any definite incubation stage or any rule for the spread of the disease. On the 24th of September, however, I came to Skaalevig myself, and so was in a position to acquire accurate information about these things and I learned the following facts: Candidate Nolsøe had been at Skaalevig three times before Whitsuntide, because a severe epidemic of influenza was prevailing in the village, the first time on the 5th, the second on the 12th, and the third on the 18th of May. On the 19th of May one of the men who had been to fetch the physician the first time broke out with the measles exanthem, and, on the 25th, one of the men who had fetched him the second time. The first man who took measles had a sister, who was a servant of the wealthy farmer J. Dahlsgaard. In spite of her master's interdiction, she had gone to see her brother, and she broke out with the exanthem on the 2nd of June (fourteen days after the brother); another maid-servant of the same farmer had visited the other man, who had developed the measles exanthem on the 25th of May, and she broke out on the 7th of June. Then the mistress of the house developed the exanthem on the 16th of June (fourteen days after the first girl); three children and two servant-men on the 20th June (thirteen days after the second girl); the master, on the 30th of June (fourteen days alter his wife); the eldest daughter, on the 4th of July (fourteen days after the younger children); and the eldest son on the 7th of July. In several houses where I sought for information about the origin of the measles, I learned that first a servant-girl or a servant-man, whose family had measles, had been infected, and fourteen days afterward, one individual, or usually several, in the house had broken out. Closer investigation showed, then, that Skaalevig, far from offering any exception to the rule, provided, on the contrary, a very complete example of the constant length of the stage of incubation, and of the fact that measles is most infectious during the period of efflorescence. The only deviation from the rule generally observed was the slower spread of the disease in Skaalevig than in the other villages, and this might seem strange in view of the fact that the residents of Skaalevig were generally said not to shun the infection of measles at all. The natural explanation of this difference is apparent on closer examination of the conditions. Skaalevig is one of the most widely scattered of the Faroese villages; either the houses stand isolated out in the midst of the fields, or two or three are grouped together; in the largest being, with six houses, measles had made its complete round when I arrived. The dwelling of Farmer J. Dahlsgaard, in which the very slow spread of measles was most extraordinary, is distinguished for its size and roominess, together with the fact that the bedrooms in it are separated farther from each other than in any of the rest of the Faroese houses. Another important circumstance I found in the fact that, as I was assured everywhere, the people in Skaalevig had been careful, especially in the beginning, to the extent that residents of houses which were still free from the disease had not gone into houses where there were sick persons, and that the heads of families had instructed their children and domestics to avoid association with those from infected houses. But at work and when meeting in the open air, the people from the exempt and the infected households had not avoided association with each other; and so it came to be said that the inhabitants of Skaalevig did not shun the infection of measles, which, strictly speaking, was not correct. A third circumstance, apparent especially towards the end, was the plainly decreasing intensity of the infection as the cessation of the epidemic drew near. Similarly, towards the end of the epidemic, the disease attacked very slowly in Kunø, Midtvaag, and Sandevaag. At the height of the epidemic, in Tjörnevig, for example, about fourteen days after one or several persons had caught measles, the majority of the residents, of the village were attacked, and only a relatively small number were spared until fourteen days after the great onset; but the people in the last-named villages fell ill gradually, so that only a few were attacked fourteen days after those who took the disease first; fourteen days later, others about fourteen days after these, still others, and so on; thus the disease lingered longer in the villages last attacked than in those that were infected earlier. Nevertheless, measles preserved withal, at least as far as my experience went, its definite period of development (from the reception of the infection to the appearance of the exanthem); and in fact, I know of no case where, after a pause of more than fourteen days, measles had appeared afresh in a village without reinfection from some other place. Nevertheless, we cannot deny the possibility that the infective material may be retained for quite a while after the cessation of measles, in wool or clothing, for instance, or in other things that are capable of harboring it.

The rule *that the contagion of measles does not produce any symptoms of illness at all, for a considerable time after it has been received into the organism, and then, according to my observations, after an indefinite prodromal period, brings forth the well-known exanthem* always on the thirteenth or fourteenth day, has thus proved constant for me in a significant series of accurate observations. It cannot be denied of course that, in addition, the constitutions of patients, their diet, etc., may he contributing factors towards hastening or retarding the eruption of the exanthem; but these differences are not nearly so great as might be expected a priori; for it appears that these external conditions are never able to hasten nor to retard the eruption of the exanthem more than about twenty-four hours on either side of its normal time, which may be considered to be between the thirteenth and fourteenth day. At any rate, I think that, after my inquiries concerning the outbreak of measles in fifty-two different villages, where I always found the above-cited rule steadfast, though often with many dates for a single village, I am justified in asking that exceptions to the rule (the occurrence of which I can by no means deny, though I have not seen them) which might be advanced in opposition to my assertions, be accurately observed, and that they should be *of such a nature as to be significant*. The examples given show clearly enough that, on more accurate investigation, *apparent* contradictions of the rule often serve to establish it more firmly than ever. In most of the alleged cases, I myself felt shaken in my faith as to a constant period of incubation, but in every instance my doubt vanished with a more *precise* inquiry. The analogy here with the information which has been acquired concerning the stage of incubation of smallpox, of fourteen days between the reception of the contagion and the appearance of the eruption, imparts to these observations, it seems to me, still greater significance.

A circumstance which may easily create confusion in these investigations is the indefinite length of the catarrhal prodromal stage. Some patients suffered for six to eight days before the eruption of the exanthem, from cough, pain in the eyes, and slight fever; others, for only from four to six days; the majority for only from two to four days; and in light cases the precursory period was either entirely lacking or lasted only one to two days. It is better not to ask the patients, therefore, when they became ill, but rather when they broke out with the exanthem, if one expects to be enlightened as to the time which the contagion requires to develop the exanthem.

If it is now regarded as a rule that the contagion of measles requires between thirteen and fourteen days after its reception into the organism to develop the exanthem, and, as numerous experiences like those which established this rule show, that there are usually thirteen or fourteen days between the time at which the exanthem appears on the patient and that at which it breaks out on his infected associates, it is then clear that the persons who are infected by him receive the contagion into their organisms at precisely the time when the exanthem is breaking out or has just appeared on him. Hence at least it is plain that measles does not infect as long as the contagion is still lying latent without producing any symptoms of illness. Whether it may be regarded as infections in the catarrhal prodromal stage, shortly before the eruption of the exanthem, is hard to decide. I saw not a few cases in which it was to be supposed from the patients' statements that they had been in contact only with persons who had prodromal symptoms but not yet the exanthem. The example cited of the young man from Fuglø who was infected in Arnefjord and the man from Selletraed who was infected in Göthe might, for instance, go to prove this. But since I so often saw persons have a good deal of exanthem on their faces without even knowing anything at all about it until I showed it to them, many first becoming aware of its presence when, after several days' preliminary course, it had broken out over their whole bodies, I do not believe that it can be accepted as certain that measles sometimes infects before the eruption of the exanthem. At least, the cases observed by me which might seem to corroborate such an opinion were of such a nature that it could not be positively asserted that there was no exanthem present on the infected persons; for in every case the rash had developed over the entire body a day or a few days later.

It has generally been maintained that measles is most infectious during the period of desquamation. I do not know whereupon this assertion is based; but I am inclined to assume that it was inferred from observing that infected associates of a measles patient first exhibited the exanthem while the patient was in the stage of desquamation. Now if the observer be not familiar with the relatively long period of latency of the contagion, it is natural that he should assume that the infection was transmitted by the first patient at a later period than was actually the case. I could not find any instance which could prove that the contagion may really be given off during the stage of desquamation, but just as little can I prove that infection may not occur in this stage. In some villages certain young persons who had not taken measles earlier and were constantly exposed to the infection remained quite exempt, being infected neither by the patients who had the exanthem nor by those who were scaling. I believe, however, in regard to the rule laid down that thirteen to fourteen days intervene between the reception of the contagion and the eruption of the exanthem, that I may assert that in the majority, if not in all the cases, the infection proceeded from the measles patients while the exanthem was breaking out or had just appeared; and no case was known to me in which a person took measles more than fourteen days after the exanthem had disappeared from the persons who might be supposed to have transmitted the infection to him. It is not impossible that the reason for this consists partly in the fact that the associates, so to speak, of the measles patients who were susceptible to infection had *already* been infected by him while he had the exanthem, and so could not be infected while he was desquamating; but it is certain that *measles is extremely infectious during the eruption and the period of efflorescence*; whereas its infectiousness in either the prodromal stage or in that of desquamation is doubtful. Whether this may be attributed to the exhalations from the patient, which are strongest during the eruption and on the first day of the efflorescence, when also the peculiarly acrid odor is most characteristic, I cannot say positively, but the supposition seems to be very reasonable.

At the suggestion of the Provincial Surgeon, Mr. Regenburg, I vaccinated sixty children on one of my rounds, to see whether the slight fever which is produced by the development of the cowpox stands in any inimical relation to the measles; but I came to the conclusion that there is no relationship at all between cowpox and measles, and that the two may lie developed simultaneously. I made no experiments with inoculation of measles, because I could expect no results with persons who had evidently been exposed to the contagion of measles; and with those who had not been exposed to infection, I feared that I might do more harm than good.

It is known to lie generally supposed that measles sometimes attacks one and the same individual twice. In this connection it is quite remarkable, however, that of the many aged people still living on the Faroes who had had measles in 1781, not one, as far as I could find out by careful inquiry, was attacked the second time. I myself saw ninety-eight such old people, who were exempt because they had had the disease in their youth. This was the more noteworthy in that a high age by no means lessened the susceptibility to measles, since, as far as I know, all the old people who had not gone through with measles in earlier life were attacked when they were exposed to infection; whereas certain young persons, although constantly exposed, were exempt. If recovery from measles sixty-five years before could insure people against taking the disease a second time, it might be supposed that still greater protection would be afforded by having recovered from it a shorter time before; and I am, therefore, inclined to assume that the cases in which measles was observed to occur the second time in the same person are attributable to erroneous diagnosis, or at least are extremely rare.

Opinion has been divided as to the degree of intensity which should lie credited to the infectiousness of measles. As a contribution towards the solution of this question, the following cases would seem to be not without interest:

On the 2nd of June a boat set off from Funding for the trading place, Klaksvig, to fetch wares. These traders were not permitted to obtain goods, however, unless they would help to unload grain from the transport-ship which had just arrived from Thorshavn. On board ship there were men who had just recovered from measles, and the business clerics in Klaksvig were just coming down with it. Upon arriving home, the men from Funding, who had been in the hold and in the warehouses, but had not been among those who were ill with measles, threw away all the paper that was around their goods, undressed completely in a kjaeld,[3] washed themselves all over with water, put on clean clothes and threw into water all the clothes they had been wearing. None of these men took measles until July 3rd, when the whole village already had been attacked. On June 3rd, another boat set out from Funding, in company with a boat from Nordre-Gjov, for the trading place. In order to obtain goods, the men from these boats were required to load the ship with dried fish. A man from Funding became ill and had to go into a house, into a room, in fact, where several persons lay sick with measles; the other men from Funding and the men from Nordre-Gjov were only in the ship's hold and in warehouses, where they stood close against other people, among whom there was a man from Nord-Øre, which had been invaded by measles. After their return home, the men from Funding did as those who had been in Klaksvig with the first boat and not one of them was taken sick until the whole village was attacked. The five men from Nordre-Gjov, who had not gone through with the same careful cleansing after arriving at home, all broke out with the rash about fourteen days afterwards. On June 8th, a third boat from Funding was in Klaksvig; there the commercial employees had just recovered from measles, and some people were there from Leervig, who were out for the first time since their recovery from measles. The men from Funding were in close contact with both the shop people and the Leervig folk. Although on returning home, they took the same precautions as those who had previously been there on business from Funding, they all, except a woman (not pregnant), were attacked by measles, breaking out with the exanthem about fourteen days later.

Kvalvig, on Nordströmø, was one of the villages where the people most dreaded the measles. Willing as the Faroese ordinarily were to convey me farther on my itineraries, and to be obliging to me in general, in Kvalvig they were so afraid of measles that they almost refused me conveyance to Vestinannhavn; and when I got their consent to take me, the man who carried my things kept at a long distance from me, and the man who drove the horse had wrapped his head up in a large handkerchief, and kept always at least three feet away from me. This was strange, for the Faroese are usually convinced that the physician never carries any infection with him; the explanation of their fear was to be found in the way in which measles had been brought to Kvalvig. The fact was that three weeks before Whitsuntide the provincial surgeon was summoned to Kvalvig, where a severe epidemic of krujm[4] was prevailing, and he had to spend the night in the village. In the house in which the surgeon had slept, measles broke out exactly fourteen days after his arrival. No other occasion than his visit could be assigned for the outbreak of the disease, since no resident of Kvalvig had been in any suspected place, and particularly none of those who lived in the house that was first attacked, and no other stranger from any of the affected or suspected places had been in the village.

From Fuglefjord, where I had visited many patients with measles, I was summoned to Mygledahl, which was still exempt. As eight men had ventured, notwithstanding their fear of the disease, to come to fetch me for a woman, who must have been very ill, it was my duty to do what was in my power to avoid carrying the measles to Mygledahl. On my arrival, in the middle of the night, therefore, I undressed in an outhouse in which fish were dried, and put on a suit of clothes which I had not had on among the measles patients. Mygledahl was not attacked by measles afterwards.

To Midtvaaq, on Vaagø, measles was carried, so people said, by the midwife, who had passed several days with the measles patients at Steegaard. The woman had had the disease herself in Denmark. In all the houses in which the midwife had been, they said, measles appeared fourteen days later; and a girl who washed the midwife's clothes immediately after her arrival was the first who took measles in Midtvaag.

These examples, which seem to prove that the contagion of measles may be carried about in clothing worn by persons who are not themselves susceptible to infection, apparently give evidence of an intensity of contagiousness which hardly otherwise would have been attributed to measles. It might have been supposed, for example, that the contagion with which the physician's clothes were impregnated would be blown away on a trip of four miles in an open boat, especially when the weather through which he traveled was inclement with wind and rain. Moreover, the cases cited in regard to the residents of Funding on their business trips appear to prove that prophylactic cleansing after exposure to infection may sometimes protect.

It is beyond doubt that the surest means of hindering the spread of the disease is to maintain quarantine. In this way, by *house-isolation*, success was attained in many villages in preventing general dissemination of the disease. Thus, in Saxen, two houses were saved from measles; in Midtvaag, ten; in Sandevaag, ten; in Gaasedahl, two; in Glibre, two; in Funding, one; in Fundingbotn, one; in Nordskaale, one; in Selletraed (at least at my arrival), four; likewise the half of Thorsvig and Lanibavig, the greater part of Kvalvig; Skaapen, and part of Skaalevig. By cutting off communication with infected localities, the residents of the following places succeeded in keeping measles entirely away: Haldersvig, with 102 inhabitants; Eldevig, with 85; Andafjord, with 121; Viderçø, with 101; Mygledahl, with 66; Trollenaes, with 29; Husum, with 54; Elankeskaale, with 51; Share, with 26; Skaaltofte, with 19; Myggenaes, with 99; Skup, with 61; Sand, with 240; Husevig, with 52; and Skarvenaes, with 26. And so, by maintaining quarantine, about 1,500 of the inhabitants of the Faroe Islands were saved from measles.

If, among 6,000 cases, of which I myself observed and treated about 1,000, not one was found in which it would be justifiable, on any grounds whatever, to suppose a miasmatic origin of measles, because it was absolutely clear that the disease was transmitted from man to man and from village to village by contagion, whether the latter was received by immediate contact with a patient or was conveyed to the infected person by clothes, or the like, it is certainly reasonable at least to entertain a considerable degree of doubt as to the miasmatic nature of the disease.

Since the doors could be locked everywhere, so to speak, against the disease, in my opinion it is not only theoretically justifiable but also practically even necessary to regard it everywhere as a contagious disease. For if people believe that the causes of the disease are *generally dispersed in the atmosphere*, they can have no hope of protecting themselves against it, and will not be disposed to take precautions in this respect, since such measures must be regarded as vain; but if it is considered as settled that measles is transmitted only to such individuals as are susceptible to the infectious material which every measles patient carries, whether the infectious matter is suspended in the air *most nearly surrounding the patient*, or is entangled in clothes and the like, there may be hope of setting limits to the spread of the disease, and the necessary provisions in this direction will be instituted with reasonable hope of a successful result. There are probably many physicians who have the same views in regard to the *miasmatic*-contagious character of measles which the two physicians of the Faroe Islands had when measles arrived in the country. Since the people were convinced that the cause of the disease could be carried through the air from house to house, from village to village, and from island to island, they did not *at that time*, think the trouble worth while to undertake an isolation, whereby the disease would probably have been limited to only a few houses. Experience, however, had taught a part of the inhabitants in 1781 that the spread of measles could be hindered by isolating places or even houses; and the aged people, who had preserved the recollection of this from their youth, effected in many places, on their own responsibility, a sort of quarantine, as mentioned above whereby the places concerned were entirely or partially spared. Not until later on, when experience had taught the physicians of the country also that the infection is quite obviously carried from place to place by *persons* and *does not jump about*, did they, too, begin to *discourage* communication with infected houses and places; but the disease had already been spread over the entire country, and from the public viewpoint it was too late to institute earnest measures towards isolation. Experience in regard to the fact that measles is *not miasmatic* but *purely* contagious in character has been so dearly bought on the Faroe Islands that the people there will probably agree with us hereafter that it is correct, at least in practice, to consider measles as a contagious and not as a miasmatic nor miasmatic-contagious disease.

It is another question whether measles can arise spontaneously. This did not happen on the Faroes, and although from a theoretical point of view, in analogy with typhus and the like, the possibility cannot be denied, yet with respect to regulations that might be instituted against the spread of the disease, especially under conditions such as those on the Fame Islands, Iceland, and other isolated places, if spontaneous origin ever occurs, the occasions are so rare that they cannot be taken into consideration.

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PART II

The Sanitary Reform Movement

Away, then, with crowded cities, the 30 feet lots and alleys, the artificial reservoirs of filth, the hotbeds of atmospheric poison. Such are our cities. They are great prisons built with immense labor to breed infection and hurry men prematurely to the grave.

—Noah Webster, 1799

The United States may be considered as a country in which no legislation exists regulating its sanitary condition.

—Committee on Sanitary Improvement, American Medical Association, 1848

CHAPTER 8

WILLIAM FARR
(1807–1883)

Sometimes she would hear a newspaper read out, and would learn how the Registrar-General cast up the units that had within the last week died of want and of exposure to the weather.

—CHARLES DICKENS, *Our Mutual Friend*, 1864–1865

WILLIAM FARR WAS BORN INTO A POOR FAMILY IN KENLEY, Shropshire, England. At the age of two years, Farr's family moved to Dorrington, where he was adopted by Joseph Pryce, the elderly squire of the town. Educated at the local school and through his access to Pryce's library, Farr decided in 1826 to study medicine. He undertook studies with Shrewsbury's Dr. Webster, supporting himself as a dresser (surgeon's assistant) in a nearby infirmary, to which he walked 14 miles daily. Three years later, Farr inherited £500 from Pryce's estate and journeyed to Paris and Switzerland to continue his medical studies. In Paris, he was introduced to hygiene and medical statistics. He is known to have attended classes by Pierre Charles Alexandre Louis (1787–1872), a physician at l'Hôpital Charité, who collected and numerically analyzed information about patients and the treatments they received. John M. Eyler suggests that Farr's interest in medical statistics did not derive from Louis alone.

In 1831, Farr returned to Shrewsbury for six month's work as a house surgeon before moving on to University College in London. The London Society of Apothecaries qualified him as a doctor one year later, although some suggest he practiced as a pharmacist. In 1833, Farr married a farmer's daughter, and the couple settled in London near Fitzroy Square. To supplement his income, Farr wrote articles on hygiene, public health, and statistics. The quality of the work commanded the attention of the editor of the *Lancet*, Dr. Thomas Wakley. In 1837, Farr completed two works of note: a chapter called "Vital Statistics" for the preeminent Victorian economist John McCulloch's reference text *Statistical Account of the British Empire* and an article on consumption (which took his wife later that same year) with Sir James Clarke. Clarke was so impressed by Farr that in 1837, when the Office of the Registrar General began operations, he and Wakley recommended Farr for the post of compiler of abstracts.

The Registrar General's Office had been created by Parliament in 1836 to track births and deaths in England and Wales as the means of assuring the proper transfer of property rights between generations of the landed gentry. Activity beyond property transfer tracking was not in Parliament's intent. Hence, Farr's appointment as compiler of abstracts did not carry with it responsibility for any of the projects Farr would take on during the next four decades.

As compiler of abstracts, Farr created the first national vital statistics system. He began the compilation of vital statistics data on an annual basis, including analyses of causes of death and assessments of mortality by occupation. To support this work, he developed the predecessor of the International Classification of Diseases. Farr was an enthusiast regarding the use of vital statistics, and his efforts in this regard were recognized by the London Statistical Society (predecessor of the Royal Statistical Society), which elected him treasurer, vice president, and in 1871, president.

Farr's advocacy of vital statistics found its way into several activities outside the bounds of the Registrar General's Office, including data and analyses for Sir John Simon's Local Board of Health, the Royal Army and Navy, and Dr. John Snow's landmark epidemiologic studies on cholera. With regard to the latter, Farr was not an early adopter of Sir William Budd's and Snow's hypothesis that contaminated water was the means by which the epidemic propagated. Until he was confronted with the 1853 cholera outbreak in Newcastle, Farr contended the spread of the disease was attributable to miasms. However, data from the Newcastle outbreak were sufficiently compelling to Farr for him to change that belief.

Farr's family life did not end with the death of his first wife in 1837. He moved to Stoke, Newington, in 1841 and remarried a year later. His second wife bore him eight children and passed away in 1876. Farr was self-taught as a mathematician and a linguist (fluent in French, German, and Italian). He maintained a strong friendship with Florence Nightingale, a nurse and activist who gained notoriety for her work with wounded British soldiers in the Crimean War. When Nightingale indicated an interest in vital statistics, Farr obliged her with data that she subsequently published.

When Major George Graham, the second Registrar General and the principal one under whom Farr served, retired in 1879, Farr made it known he wished to be Registrar General himself. He did not receive the appointment, and in consequence, he retired in 1880. Three years later, he died.

A Note on the Text

The three readings by Sir William Farr selected for this volume all derive from Farr's early career. The first, "Lecture Introductory to a Course on Hygeine, or the Preservation of The Public Health," was published in 1835 and is an example of the writings that convinced *Lancet* editor Thomas Wakley to nominate Farr for the compiler of abstracts position in the Registrar General's Office. In it, Farr reviews past doctrines on hygiene. He does not provide any sense of his personal view on these diverse doctrines, simply noting their existence as a basis for efforts to be effected in Victorian times. The other two pieces focus on data collected by the Registrar General's Office. One provides a comparison of mortality between places in England and Sweden. The careful reader will observe Farr's demonstration of the presence of confounding by age and his proposed solution to that situation—indirect adjustment. The third reading exemplifies Farr's careful approach to analyzing data collected by the Registrar General's Office. Although the specifics of the reports changed as knowledge about specific diseases was discerned, the general tenor of those reports is well captured in this selection.

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Lecture Introductory to a Course on Hygeine, or the Preservation of The Public Health
(1835)

Gentlemen:—The subject of *Hygeine*, as far as I know, has not yet been treated in a course of lectures by any one in the metropolis; consequently the attempt which I am this evening about to make, presents more than the ordinary difficulties of a first lecture, and must plead for the exercise of more than an ordinary degree of indulgence. Instead of entering directly on the matter of the course, as should be done, were the general nature of the subjects to be discussed thoroughly comprehended, I shall, after examining the history of Hygeine, endeavour to lay before you an outline of the whole course, and direct your attention to some illustrations which may enable you to appreciate, at their just value, a few of the points of view from which we are about to examine Human Life.

"Hygeine" is a naturalized French word, taken from the Greek υγίείά or υγείά, health. In its present form it is not, as Dr. Forbes has judiciously remarked in his "Bibliography," very agreeable to the English ear; and I should have adopted the term *Hygiology*, but from the dread of attempting two innovations. It is considered equivalent to *the art of preserving health*; and while the exercise of *Therapeutics* restores the sick to health, *Hygeine* is said to teach how life is preserved. Life is valuable,—"All that a man hath will he give for his life,"—and health is a blessing which sweetens every other joy, or bears men up even against misery; so when private individuals only are considered, health and the extension of existence should be the primary objects of Hygeine; to be attained at the expense of almost any sacrifice. Every member of the body may be lost, all its form and loveliness may have perished around it, the intellect itself may be gone, and man may remain,

> "Sans teeth, sans eyes, sans taste, sans everything,"

and yet may it be our duty to protract animation to its utmost span. Even with the most destitute individual, in the most forlorn condition, nothing could justify the neglect of every necessary sanatory *[sic]* precaution, except the inevitable moral wreck of the heart, to survive which—to sacrifice our solemn duties, friends, country, or truth, for life, and so, *propter vitam perdere causas vivendi*,[1]—hygeine itself offers no incentive.

Although the preservation of health and its prolongation of life are the great objects constantly to be kept in view in private hygeine, they are subordinate in public hygeine, where nations are considered to the higher end of developing the human faculties, and raising them to their greatest possible degree of organic perfection. Regarding mankind with a general eye, would an intelligent being desire to see a feeble, imbecile, effete population, vegetating through an antediluvian age of some eight hundred winters; or would he attempt to call forth all the energies of humanity, to flourish for a few years or generations, and then to ebb with terrible revulsion? Would he not rather seek to temper the intensity of life, so that, when multiplied by time, the greatest possible sum of vitality might be produced?

"Hael," the Saxon root of "Health," implies *strength*—hence we have "a hale man:"—and "Healer" was a bestower of Health. "Physician" and "Saviour" were translated by the Saxons "Healer." In speaking of the preservation of health, I wish health to be understood as implying not only that smooth course and equilibrium of the functions which is now commonly indicated by the word, or the state to which patients are restored after sickness,—but the *strength* and continued energy of the mental as well as the muscular system. "Cultivation" would be a more appropriate term than "preservation;" as the latter implies only *continuance*, while "hygeine" employs all external influences, and all our knowledge of the organs, the functions, and the habitudes of the human economy, not merely for its *preservation*, but for its *improvement*.

The true object of hygeine, then, is to increase the *sum of vitality* by extending individual life to its full term (averting death); by obviating sickness; and by increasing the energy of all the vital forces, whether nutritive, formative, locomotive, or sensitive and intellectual.

A history of life, of the natural and supernatural means which nations and legislators have employed for its preservation, the plans proposed by enthusiasts, and the valuable precepts which medical men and philosophers have successfully deduced from the observation and experience of mankind, would afford us abundant instruction; as it would show the human mind at issue with a problem of the greatest practical importance, and the highest speculative interest. My first step, however, on this occasion, shall be directed to signalizing some of the chief cultivators of hygeine;—to direct you where to refer for more ample information on the subject than can be furnished in these lectures,—and to guard against some false doctrines, which float like warning wrecks on the surface of its past history.

Egypt was considered by the ancients to be the seat and source of medicine. The observance of great bodily cleanliness, strict regimen, mild diet, from which the use of several animals was proscribed; vomiting, purging, and fasting, for three days successively every month; and a simple, invigorating education, inuring the youth to hardships,—these were some of the doctrines of the Egyptians, and formed part of their laws. Physicians were included in the learned class; constituting one all-powerful priesthood, to whom a third of the land was allotted. They practised their art for the advantage of poor and rich indiscriminately, their endowed riches raising them above the necessity of requiring fees. In the time of Herodotus, it is said, the plague was entirely unknown among the Egyptians, many of whom attained a great age.

The four last books of the Pentateuch unfold a great system of hygeine, not constituting a mere philosophic unapplied theory, but enforced by legal sanctions, and carried out in practice to the very letter of its enactments. Moses was learned in all the wisdom of the Egyptians, and adopted several of their practices; but together with the great idea of emancipating his countrymen, and carrying them from a land of bondage to a land overflowing with natural riches, came many profound principles of truth, resulting from the study of the moral and physiological condition of mankind, and a thorough knowledge of the external circumstances,—of the country—the wilderness,—through which people were to be led. On account of the relation of miracles mingled with the narrative of Moses, some persons object to references being made to the Pentateuch; or to considering it as historical authority for scientific truths; but internal and circumstantial evidence proclaims its authenticity too strongly to justify the rejection of the facts which it contains, whatever differences of opinion may attend their interpretation. Voltaire says that every thing about Moses is supernatural: "Chaque peuple a ses prodiges, mais tout est prodige chez le peuple juif."[2] After examining the records collected in the Pentateuch, the manners and the style of the Arabs, and all the other attendant circumstances, I think you will come, if not with Warburton, at least with Muller and Roetteck, to a different conclusion. I shall here assume that the facts are historical, and proceed to develop a faint outline of the Mosaic system of Hygeine; important, because it is the first recorded with detail, and because of the mighty principles it involves. The great theological system revealed by Moses, I am neither qualified nor called upon to discuss; in hygeine we have only to do with the physical facts.

Moses, *after carefully distinguishing the contagious diseases of the Israelites, commanded that the infected should be isolated*.—

In *Leprosy*—a cutaneous affection allied in character to Tubercular Elephantiasis—the suspected man was brought to the priest, who pronounced him "unclean;" or, if there were any doubts, shut him up for seven days, until the symptoms of the case became well marked. The "unclean" were put without the camp, and only visited by the priest; their clothing was burnt. When the people possessed settled habitations in Canaan, unhealthy houses were directed to be examined, and "scraped within and round about," the dirt thus taken off being carried out of the city to an "unclean" place. The worst buildings were to be entirely broken down and removed.

In the disease of *Gonorrhœa*, the identity and antiquity of which, will, I think, appear indisputable to those who read the 15th chapter of Leviticus, every thing and every person touched by the patients, was declared "unclean"—to be set apart and purified by washing. Seven days of purification were prescribed for the cleansing of the impure person; who afterwards offered before the congregation "two turtle-doves or two young pigeons." The minute regulations on this head deserve your attention; so do those relative to the menstruation of females, to their purification, and to cohabitation, particularly in the East, and among the Arabs. Circumcision, still practised among the same races, and, in some tribes, upon females, was intended to promote cleanliness; perhaps to prevent some diseases of the prepuce; or to obviate phymosis and paraphymosis. It was performed on the eighth day after birth; and often must have destroyed the most *weakly* children, who would bleed to death, or die convulsed; at least such a result has sometimes been observed among the German and Polish Jews. "A bloody husband," said Zipporah to Moses, "art thou, because of the circumcision."

Animals were allowed for food, but a great many species were prohibited. "Whatsoever," says the Jewish law, "parteth the hoof, is cloven-footed, and cheweth the cut, ye may eat:" swine were excluded because they did not ruminate; coneys and hares because their hoof was not divided. The prohibition of hares would recal [*sic*] to mind the modern Game Laws, were it not in conformity with a *principle*; and did we not know that Moses always carried out his principles to their most rigorous consequences. Birds of prey, "whatever in the waters hath neither scales nor fins, whatsoever goeth upon its paws," and all flying creeping things, except locusts, grasshoppers, and beetles, were forbidden. The latter flying creeping things were, probably, not unacceptable in the wilderness. The ox, the sheep, the goat, the deer, and the chamois, were orthodox food; in fact, the classification excluded few animals which we now eat, except swine, hares, and rabbits. Everything that "dieth of itself" was pronounced inedible; and the blood of all animals was to be poured out.—"Ye shall eat the blood of no manner of flesh; for the life of all flesh is the blood thereof." *Lev*. xxii, 14. Blood is rarely taken by Europeans, although it is drunk by some carnivorous animals and savages. It is not very palatable, but I am not aware that blood is indigestible. Some think that this enactment was intended to prevent cruelty; in support of which, Bruce relates, that somewhere in Abyssinia, the fierce nomads drive their cattle and cut steaks from them as they are needed; but this very much resembles Mizeld's story of the goose.[3]

The enactments relating to marriage, which are now adopted in Europe, were founded on the physiological law, that a degenerate offspring results from the intercourse of animals which are nearly related; and that a proper mixture of alien blood, can alone give birth to an untainted and vigorous race. Cousins and near relations, by being brought into contact when young, and when the affections are opening, too often lay the foundation of matrimonial alliances which infringe upon the general laws of Hygeine. What would have been the result of allowing the connubial union of nearer relatives? The denouncements of adultery, which was punished by death, and the strict investigation of virginity, discouraged promiscuous intercourse,—destructive of the bonds of families, calculated to yield a degenerate spurious issue, and likely to involve nations in exhausting pernicious diseases. Such a restraint was necessary, as, in the language of Beaumarchais, man is the only animal "qui boit quand il n'a pas soif; et qui fait l'amour en tout temps" [who drinks when he isn't thirsty and makes love whenever—Ed.].[4]

The Levites (the priests or learned caste) were the medical advisors of the people: they were remunerated from the tithe, and received offerings on recovery. Jehovah himself was his people's physician; and on condition of their hygeiaic and religious obedience, declares, "I will take sickness away from the midst of thee; the number of thy days I will fulfil [*sic*]"—the great aims of our art.

Moses, assisted by the princes of each tribe and the high Priest, made two enumerations of the people, distinguishing "their families by the house of their fathers, with the number of their names, every male by their poll, from twenty years old and upwards, all that were able to go forth to war in Israel." The first census was made by assembling the congregation together on the first day of the second month, in the second year after they were come out of Egypt; 603,550 males above the age of twenty were enumerated. The force of each tribe is stated; the Levites, a month old and upwards, amounted to 22,000; the first-born of all Israel 22,274. The males above twenty in western Europe constitute about a quarter of the total population, so that 600,000 males imply a total population of 2,400,000. Many believe that there is an error in this enumeration, but it is not necessary to examine the arguments on either side here; I only call your attention to it as the first census recorded, and to the fact that Moses employed this enumeration of the males of twenty years old and upwards, as a measure of the strength of the population at his disposal.

Before him were the thousands of Israel reluctantly torn from slavery, debased in intellect, and corrupted by circumstances, but now safe from Egyptian pursuit: Let us ask "what was the hygeinic problem which Moses had to solve?" His great and avowed purpose was to put the Israelites in possession of Palestine, already fenced with walled cities, and guarded by a warlike population; the difficulties to be overcome were the traversing of an uncultivated but not extensive desert, obtaining supplies of food, and converting a race who were rendered dastardly and feeble by bondage in warlike progenitors of an exterminating people, to extend its numbers from Lebanon to the Euphrates. Led to action in the first year, the unwarlike combatants, affrighted by the Egyptians, and easily turned aside by other small tribes, were driven back by the Amorites, like swarms of bees. Moses, from the moment of that defeat, devoted the entire generation to death in the "terrible wilderness," where pestilence, thirst, and hunger, in the course of forty years, destroyed all that bore arms (above twenty years of age), and only allowed the stronger children to grow up for the purposes of war, disciplined by the Mosaic laws. In the accomplishment of his designs, the lawgiver spared no lives; at Sinai 3000 rebels of his own people were slaughtered. The conquered tribes were exterminated, and their riches were appropriated; or the women only, who had not known men, were saved, to augment the number of children. Notwithstanding the waste occasioned by death or war, on numbering the Israelites a second time, at the expiration of thirty-eight years, the great legislator records with dignified satisfaction, that the males of twenty years old and upwards still amounted to 601,730, animated by a very different spirit, and a far higher degree of vitality, than languished round the whitened bones which were sleeping in the desert. With the prophet called to curse them, gazing on one hand over the country they were about to possess, on the other over "Israel abiding in his tents;" his enraptured lips might well exclaim, "Who can count the dust of Jacob? How goodly are thy tents, O Jacob! and thy tabernacles, O Israel! As the valleys are they spread forth, as the clear tree beside the waters. God brought him forth out of Egypt. He couched, he lay down as a lion, and as a great lion, who shall stir him up!" Thus Moses left the Israelites, a numerous nation, raised by great principles, a system of laws, and hygeinic adaptations from slavery, and perfectly fitted to its great destiny; and thus he accomplished one of the most interesting physical regenerations recorded in early history. In contemplating this mighty work, shadowing forth preconceived ideas, and the result of theoretical principles, rigorously and sometimes cruelly enforced, the fugitive herdsman of Jethro, on the volcanic Sinai, standing before a rebellious people, and viewed with an enlightened philosophy, must remain for ever sublime in character, as he was conceived by Angelo.

Turning now from Egypt and the southern shores of the Mediterranean, let us direct our attention, northwards, to the coast of Asia Minor and Greece, where the first temples were raised to Esculapius and Hygeia, and where human culture developed to a high degree all the physical and psychical powers of our nature.

The constitution of Sparta, founded on simple principles, and professing as its determined purpose, the development and equal distribution of physical strength and vitality among all the citizens, presents another remarkable example of the influence of hygeinic agents of races of men.

Some degree of uncertainty hangs over the early history of Lacedemonia and that of its lawgiver Lycurgus. We do not know in what precise hygeinic condition he found and left that people; but it is almost certain, that after journeying several years, studying the laws of Minos, comparing the effects of Cretan simplicity with Ionian luxury, and making himself acquainted with the physical condition and the philosophic doctrines of the surrounding nations, Lycurgus returned to Sparta, and established a new legislation, founded on education, which he looked upon "as the greatest and most glorious work of a lawgiver." The children were taught to endure labour, to fight, and to conquer; they were lodged in the country; went barefooted, played naked or wore one upper garment, and slept together on rushes. They were fed on coarse spare diet, exposed to alternations of hunger and thirst, bodily suffering, and fatigue, and practised severe gymnastic exercises. After an animal is born, its character and nature are cast and fixed. So the education of Lycurgus began before birth. He sought at its source and root to fashion the Spartan race in the iron mould of his system; for this purpose he first reduced, according to Aristotle, the women to some rule: "he ordered the virgins to exercise themselves in running, wrestling, and throwing quoits and darts; that their bodies being strong and vigorous, the children afterwards produced from them might be the same. At certain festivals they sang and danced, unapparelled, but with all modesty, before the fathers, the young men, and all but the mocked and scorned bachelors of the city; and, to use the expression of Plato, drew the young almost as necessarily by the attractions of love, as a geometrical conclusion follows from the premises. On marriage, the bride was carried off by violence; and only seen illicitly by the bridegroom, neither oppressed by wine, nor enervated by luxury (Plutarch). The father could not rear his own offspring before he had carried it to the elders; who, if the child was strong and well-proportioned, left it with the mother, and gave orders for its education by the state; but if it was weakly and deformed, commanded it to be thrown into a deep cavern near the mountain Taygetus. The women, too, washed their new-born babies with wine, to try, Plutarch correctly adds, "their habit of body; imagining that sickly and epileptic children would sink and die under the experiment, while the healthy would become more vigorous and hardy." The public education began at the age of seven years. For further details on the Spartan education, I must refer to Plutarch, Xenophon, and Pauw. These outlines present a picture sufficiently revolting to the better feeling of this age,—to us of the nineteenth century, who send foundling to hospitals, nurse scrofulous infants, and educate the children, even of the labouring poor, in workhouses. Yet revolting as this system seems, it formed Leonidas, and the three hundred who fought and died at Thermopylæ "to obey the sacred laws of their country." It was founded on physiological laws, and realized at a great expense of suffering and life, the idea of Lycurgus, in producing a chosen nation, endowed with extraordinary energy and an uncommon degree of vitality.

This investigation of the hygeinic legislation of the Hebrews and the Spartans, appears to me to preclude, to a certain extent, the necessity of further historic inquiry into the hygiene of ancient and barbarous nations, for their institutions embody the practices not only of the early, but of the modern uncivilized nomad and fixed tribes which are scattered over the earth, and present them in a tangible, but improved and refined system. Hunger and necessity exposed the North American Indian to the hardships and dangers, the alternations of heat and cold, the inanition and fulness [*sic*] which the Spartan laws enjoined; the Indians were taught manual dexterity; their eye and senses were keen; they too could endure corporal suffering; and smile in the very pangs of death; they also disciplined their women, and abandoned their weak children. And so it was not only in North American, but in South America, and among all the vigorous races of savage men which we now call "barbarians."

In order to understand a system which attempted to augment the sum of a people's vitality, by eliminating and pruning remorselessly away all the weak shoots, imagine 1800 children born on the same day at Sparta. They are taken before the elders, and a certain number are rejected; those that are strong and well-proportioned are carefully educated, and their bodies are tempered by discipline to the circumstances in which they are destined to move; after the expiration of twelve years, only 1000 remain. Now conceive the same number (1800) born in a neighbouring city, where the circumstances are nearly the same, with the exception that all the weakly children are tenderly brought up, till they are driven by necessity from their parents' arms. How many of such children would be alive at the end of twelve years? Not all, but probably more than 1000, more lives would exist than at Sparta, but the vitality of many of these saved children would be feeble, their lifetime would be impaired by sickness, and *afterwards,* in youth and in manhood, they would be swept away by the implacable severities of a rude and uncivilized state, if these were not by some accident averted. If they lived to possess offspring, and that offspring extended to three or four tuberculous, scrofulous, enfeebled generations, their proportion would be augmented; while organic debility was weeded from the Lacedemonians, the North American Indians, and vigorous barbarians, in its germ, by the laws, and by the stern discipline of nature.

The Russians, in an extreme climate of rapidly alternating heat and cold, still bathe their young infants in the cold rivers, and then bring them suddenly to the warm stoves, to harden their constitution, according to Russian writers. I shall prove from experiments, and the relative mortality of infants in the warm and cold months, that extreme cold destroys the young of all warm-blooded animals; whence it may be inferred that these cold-baths are a summary substitute for both the Spartan examination, and the deep cavern near Taygeus. That some great cause of mortality exists among the Russian children none will doubt, when they learn from Sir Francis D'Ivernois, that at Nigni, near Novogorod, out of 1000 baptisms, 661 die before attaining their fifteenth year; but whether the cold-baths, the cold climate, or the want of food, contributes most to this lamentable destruction, we cannot decide. It is generally agreed that there is a considerable proportion of old men in Russia, and this has been adduced in proof of the longevity and health of the entire population.

Among the most civilized nations of modern Europe, out of 1600 or 1800 children born, only 1000 remain alive at the end of the 12th year. According to the accurate calculations of Mr. Edmonds, founded on the last population and parish register returns, the annual deaths in England and Wales, for the first five years of life, were 46 per cent in the six years elapsing between 1818–24. Admit that the mortality in infancy has been greater, and that many of the weaker children had perished, is it not probably that the mortality in manhood would have proportionally declined? The state of mortality in Belgium entitles us to answer this question in the affirmative. In Belgium, 66 infants, between birth and five years of age, die annually per thousand; and in manhood, between twenty and thirty years of age, 9; between thirty and forty, exactly 10 per thousand perish; while, at the same ages in England, 10 and 12, instead of 9 and 10 per thousand are lost. You perceive here an oscillation in the line of vitality,—in the proportion between the dying and the living. If it is lowered at one time, it rises correspondingly at another. Again, where the temperature, the place, or the social condition, renders life difficult of preservation,—where the external hygeinic conditions on which our physiological processes depend are unfavourable,—the deaths in infancy are immensely augmented, in order to raise the subsequent period, destined for the production of the species to a certain pitch of vitality, below which its generations would cease. In the cold climate of Sweden, instead of 45, as in England, 90 per 1000 died annually in infancy (1755–75). Between the ages of twenty and forty, however, the mortality was not quite so great as in this country. In Stockholm, out of 3000 born, only 1000 survived the twelfth year. You conceive, perhaps, now, that notwithstanding the sacrifices of infants, the sum of vitality may, possibly, have been as great in Sparta as in other and worse climates, where cold destroyed the young, or even in the same climate where the infants were reared.

If, for a moment, you examine the fine races of dogs, of sheep, of oxen, in this country, or the fleet race of English race-horses, you will find that the system of breeding and training—directed not to increase the longevity of those animals, but to give them muscular strength, velocity, and sagacity, or simply weight and flesh,—has been eminently successful. I will not here dwell on the system which those who breed these animals adopt; I shall recur to that on another occasion, and now only call your attention to one fact—viz. that they invariably *reject,* and never *breed* from, those animals which do not possess that vigour, sagacity, or well-favoured aspect, which they aim at rendering permanent in a race. If every sickly, puny, cowardly, stupid individual was necessarily retained, and all were allowed to associate promiscuously, the present perfect animals would speedily degenerate, like neglected uncultivated vegetables, to their primitive state of wildness. The extension of these principles, deduced from the observation of domesticated animals to the human species, constituted a main feature of the laws we have just passed in review; many of which are now, happily, discountenanced, alike by humanity, and a more enlightened hygeine, and by all the governments of civilized Europe, except Russia. In the next lecture we shall examine the hygeinic doctrines of Hippocrates, Galen, and the moderns, and present some illustrations of the influence, and the means of measuring the influence, of hygeinic agents.

Source

Farr, William. "Lecture Introductory to a Course on Hygeine, or the Preservation of The Public Health." *Lancet* 1. 637 (November 14, 1835): 240–245.

On the "Table of Mortality" for the Metropolis
(1840)

I find, upon an average, that 14,000 persons die annually in Paris. This is a fine battle. (C'est une belle bataile.)

—Napoleon

The *Table of Mortality*, for the Metropolis, came into operation on the 5th of January, 1840; and presents an abstract of the deaths registered in the first week of the year 1840. As it differs essentially from the *Bills of Mortality*, and is to be continued weekly, I have drawn up a few observations on the facts which it embraces, that its nature and application may be more readily apprehended by medical readers.

The Table exhibits, by a very simple arrangement, the state of public health, in connection with atmospherical and other changes. Its principal indications will be accurate as the results of meteorological observation; and it is calculated to lead to the discovery of the sources of disease, of the laws of epidemical visitations, and of the means of controlling their ravages. It will give a timely intimation of the approach of epidemics, guide the practice of medical men, and impress upon the public mind, by frequent reiteration, that diseases prevail to a great extent, and depend upon evident causes, which may, in many instances, be removed.

I shall give, in the present article, a rapid account of this instrument of statistical investigation; and, at another time, review the physical circumstances which appear to regulate the mortality and sickness, with the view of ascertaining whether the health of the inhabitants of the metropolis, and of all the cities of the kingdom, is not susceptible of great amelioration.

The Metropolitan Division extends from Hammersmith and Chelsea, in the West, to Woolwich, in the East; and from Stoke Newington in the North, to Camberwell and Dulwich, in the South. Its area is 70 square miles, nearly equal to a circle of 9 ½ miles in diameter. The population enumerated in 1821 was 1,328,671, which, in 1831, had increased to 1,594,890. The Metropolis is divided into 32 Superintendent Registrars' Districts, and subdivided into 125 Registrars' Districts. (First Report of the Registrar General, 1839) Each Registrar fills up the subjoined Schedule, and forwards it by post to the General Register Office every Monday morning. The Table is an abstract of the Registrars' returns:—

Return of Age and Cause of Death in all Deaths registered during the Week ending Saturday, the 11th Day of February, 1840.

Superintendent Registrar's District of Kensington.
Registrar's District of Saint Mary's, Paddington.

Females[1]

No. of Entry in Reg.	Age	Cause of Death
271	29 hours	Exhaustion
272	5 years, 1 month	Scarlatina

The causes of death have been arranged in the same groups, as in the Annual Report of the Registrar General. The nature of the classification, and the principles upon which this nomenclature was fixed, are stated in the Appendix to the Report (p. 89–99); to which I refer those who consult the "Table of Mortality," for explanations, which it is unnecessary to repeat. In the Table several diseases are thrown together, and distinguished in notes. This abridges the list, without diminishing its completeness or value.

The deaths from each disease, and class of causes, have been given for three periods of life,—childhood, manhood, and old age. The distinction will furnish many striking results, and a more minute sub-division of age would be *useless* in a weekly Table of Mortality.

It will be observed, that the deaths (Jan. 5–11th) under 15 years of age, amounted to 404; at 15–60 years, to 332; and 60 and upwards, to 230; while the age of one person, who died a violent death, was not ascertained: 967 deaths were registered in the week. To determine, at a glance, whether the rate of mortality was high or low; whether the week was healthy or unhealthy; a standard was required with which the weekly deaths could be readily compared. The deaths in the year 1838, divided by 52, will furnish this standard, temporarily; and in the column headed weekly average, have been placed against the deaths in the week to which the bill applies. Thus it will be found, that the average weekly deaths (1838) were 1,013; and, consequently that the mortality in the week ending January 11th, 1849, was below the average, nearly in the proportion of 967 to 1,013. This is the first important fact which the arrangement exhibits. A comparison of the "weekly average, 1838," with the adjacent column of the total deaths from each cause will show what diseases prevail with a less or more than the ordinary intensity; and a comparison of the two lines of figures, at the bottom of the Table, will indicate at what ages the diminution of mortality was felt.

The Table furnishes answers to the three questions:—Is the season unhealthy? What diseases prevail? What ages do they principally affect? Another question remains:—What localities do they infest? And in tracing the origin and progress of epidemics, its importance will be apparent. To answer this question the metropolis has been divided into 5 divisions; comprising, (1) the West Districts, (2) the North Districts, (3) the Central Districts, (4) the East Districts, (5) the South Districts. In the second part of the Table, a column on the right hand presents the average weekly deaths in each of the five divisions, in juxtaposition with the deaths in the week under observations.

THE WEST DISTRICTS are 5 in number: Kensington; St. George Hanover-square; Westminster; St. Martin-in-the-Fields; St. James. The division includes Hammersmith, Fulham, Chelsea, and Paddington in the West; and is bounded on the East, by the Edgware-road [*sic*], Oxford-street, Wardour-street, Princes-street, Leicester-square, Castle-street, Drury-lane, the Strand, Cecil-street, and the Thames.

THE NORTH DISTRICTS are 4: St. Marylebone, St. Pancras, Islington, Hackney. They extend North to Kilburn Priory, Primrose Hill, Kentish Town, Holloway, Hornsey, Stoke Newington; from the Edgeware-road, in the West, to the River Lea in the East; and the Southern boundary is formed by Oxford-street, Tottenham-court-road, a line running a little South of Francis-street, across Gower-street to Compton-street, thence to Guildford-street, and the West side of the Clerkenwell House of Correction, the Lower Road Pentonville, Pentonville, Goswell-street, the Regent's Canal, Providence-row, and ending near the While Post-lane, Hackney Cut.

THE CENTRAL DISTRICTS comprise, the Strand, St. Giles and St. George Holborn, Clerkenwell, St. Luke, West London, East London, City of London. The Western boundary has been described under the West Districts; but St. Paul, Covent Garden, which belongs to the Strand Union, is surrounded by the District of St. Martin-in-the-Fields. The North boundary is formed by the North Districts; the East passes by the Basin of the Regent's Canal, Edward-street, City-road, Old-street-road, Wilson-street, Long-alley, the Minories, Rosemarey-lane, Great Tower-hill; the South by the Thames.

THE EAST DISTRICTS, Whitechapel, Shorditch, Bethnal-green, St. George in the East, Stepney, and Poplar, are bounded on the South by the Thames; the east by the Lea River; the north by the North Districts; the east by the East boundary of the Central Districts.

THE SOUTH DISTRICTS are Lambeth, Newington, Southward, St. Saviour, St. Olave Bermondsey, Camberwell, Rotherhithe, Greenwich. The Greenwich District, in the East, includes Woolwich and Deptford; Camberwell extends to Dulwich; Lambeth to Norwood. The Thames sweeps round the Northern Districts of the division.

The old Bills of Mortality included Lambeth, Rotherhithe, Popular (exclusive of Bow and Bromley), Islington, and Hackney (St. John); but did not include Kensington, Marylebone, St. Pancras, Camberwell, or Greenwich. The population of Greenwich has the greatest affinity to that of the East end of the metropolis. It is not so low down the river as Poplar; and if any contagious disease should be imported into the metropolis, it would probably appear first in the lower parts of the river. Greenwich is, therefore, properly included in the Table of Mortality for the metropolis.[2]

In the four decennial enumerations, the population of the metropolis was found to increase very uniformly, at the rate of 1.8 per cent., annually. It may be assumed, that the rate of increase has been the same since 1831; and that, with the addition of 4 per cent., as a correction for soldiers, sailors, and other persons not enumerated, the population in the metropolitan division will amount, by the middle of 1840, to about 1,955,000. The weekly deaths are nearly 1.52nd part of the annual deaths; divide 1,955,000, therefore, by 52, and the quotient, 37,596, will serve, as the divisor of the weekly deaths, to determine the *annual* rate of mortality prevailing in any given week. The average weekly deaths in 1838, were 1013. If the population had been as numerous as in 1840, the weekly deaths in 1838 would have amounted to 1051; and 1051 divided by 37,596=.028, or, a mortality of 2.8 per cent. per annum. The experience of a *week* in the metropolis is equivalent to the experience of a *year* in a town with a population of 37,596.

The mortality, in the year 1838, appears to have been a near approximation to the average mortality of the metropolis. It was 2.80 per cent.; while the mortality of the 18 years, 1813–30, as deduced from the parish registers, with a correction for omissions, was 2.84, according to Mr. Edmonds, and 2.93 in the 10 years, 1801–10, according to Mr. Milne, the two best authorities on the subject. The distribution of the deaths at the three periods of life was, also, it would seem, not very different from the average. The *epidemic diseases* vary considerably from year to year.

The ages of the population were unfortunately not enumerated in 1831. To obtain an approximation to the numbers living, at the ages 0–15,

Age	0–15	15–60	60–
Males	3428	6066	506
Females	3045	6371	584
Mean	3237	6218	545

15–60, 60 and upwards—we can, therefore, only take the proportions existing in 1821, which were stated by Mr. Rickman to be, in 10,000:—

Hence it may be inferred, as the population has increased regularly for many years, that the numbers living in the metropolis, in the middle of the year 1840, will be nearly as follows, at the three ages:—

Age	Living	The Number Living Divided by 52
0–15	632,833	12,170
15–60	1,215,618	23,377
60–	106,549	2,049
All Ages	1,955,000	37,596

Divide the weekly *deaths* at the three ages by the corresponding numbers living—12,170—23,337,—and 2,049,—and the result will represent nearly the annual rate of mortality prevailing in any week of the year 1840.

Annual Rate of Mortality per Cent

Age	Jan. 5–11, 1840	(1838)
0–15	3.3	4.0
15–60	1.4	1.6
60–	11.2	9.7
All Ages	2.6	2.8

If the average mortality (1839), be taken as the standard of salubrity, and be represented by 1, the health of the week will be represented by 1.09,—of children 1.20, adults 1.14, old people .87.

The ages of the population of Sweden are enumerated every 5 years; the mean numbers living, deduced directly from the 3 enumerations of 1810, 1820, 1830, and the average annual deaths in the intervening 20 years, are subjoined for comparison with the similar facts in the metropolis:—

The relative number of persons above 60 is the highest in Sweden; while the proportion between 15–60 is the highest in the metropolis. The immigration of adults into the metropolis, and the greater mortality of cities, render this inevitable.

Age	Mean Numbers living 1811–30	Annual Deaths 1811–30	Annual Mortality Per Cent
0–15	867,804	27,213	3.14
15–60	1,526,745	19,537	1.28
60–	222,326	17,720	7.97
All Ages	2,616,875	64,570	2.46

Relative Ages of the Population of Sweden, of the Metropolis, and of England

Age	0–15 15–60 60– All Ages
Sweden. . . . . (1820–30)	3,316 + 5,834 + 850 + = 10,000
Metropolis . . (1821)	3,237 + 6,218 + 545 + = 10,000
England . . . . (1821)	3,999 + 5,348 + 743 + = 10,000

The following Table exhibits the population of the 5 divisions of the metropolis in 1821 and 1831; the area in square miles, the annual rate of increase, and the estimated population, July 1, 1840.[3]

	Population		Area in Square Miles	Annual Rate of Increase per Cent	Estimated Population, 1840
	1821	1831			
West Districts	211,564	252,761	17.2	1.8	308,921
North Districts	215,459	297,597	17.3	3.3	414,458
Central Districts	339,590	355,502	2.7	0.46	369,722
East Districts	271,296	330,736	8.8	2.0	411,634
South Districts	290,762	358,294	23.9	2.1	450,265
	1,328,671	1,594,890	70.0	1.8	1,955,000

The increase of the Central Districts in 10 years was not 5 per cent., and it occurred chiefly in the Districts of Clerkenwell and St. Luke, which, by 1831, had scarcely any vacant space left for building. Houses have since been taken down in the City of London, and in other Districts. Hence, as has been assumed in the above estimate, it is probably that, since 1831, the population has remained nearly stationary in the Central Districts.

Soldiers, sailors, and a certain proportion of the floating population of

	Estimated Population 1840, divided by 52	Weekly Deaths (1838,) Corrected	Annual Rate of Mortality per Cent	Density; or, Number of Inhabitants to a Square Mile
West Districts	5,941	162	2.73	17,982
North Districts	7,970	181	2.31	23,198
Central Districts	7,112	210	2.93	150,283
East Districts	7,916	249	3.15	41,791
South Districts	8,659	248	2.87	18,075
Metropolis	37,596	1,051	2.80	278,923

the metropolis, were never enumerated. The proportion omitted has been estimated by Mr. Rickman at 4 per cent.; and this correction has been applied in the preceding calculations, although it is probably that the unenumerated population was not equally distributed over the 5 divisions. The unenumerated were principally males; and the following were the numbers of males and females enumerated in the 5 divisions in 1831:—

1831	Males	Females
West Districts	11,5775	136,986
North Districts	130,696	166,901
Central Districts	170,896	184,666
East Districts	155,499	175,237
South Districts	166,853	191,441
	739,719	855,171

The deficiency of males was greatest in the North Districts, and least in the Central Districts; but it is not probably that the proportion of unenumerated males was greater in the North than in the South Districts. The proportion of females in excess appears to have some connection with the increase in population. The females enumerated were 28 per cent. more numerous than the males in the North Districts; 13 to 18 per cent. in the West, South and East districts; and 8 per cent. in the Central Districts, where the population increased (1821–31) only ½ per cent. annually; while it increased about 2 per cent. in the West, South, and East Districts, and 3.2 per cent. in the North Districts.

	Females to 1 Male enumerated 1831	Annual Rate of Increase per Cent
West Districts	1.28	3.3
North Districts	1.18	1.8
Central Districts	1.15	2.1
East Districts	1.13	2.0
South Districts	1.08	.5
Metropolis	1.16	1.8

In Great Britain, including the army, the navy, and registered seamen, the proportion of males to females, in 1831, was 1:1.026, with which the preceding proportions for the Metropolitan Districts may be compared.

The hospitals are distributed over the 5 Districts, and can exercise little disturbing influence upon the relative rates of mortality.

January 23, 1840.
HEALTH OF THE METROPOLIS

The Week ending January 11th, 1840.–

The mortality was below the average; in other words, the *health* of the week was 9 per cent. above the standard. The temperature fell below the freezing point, and remained low during the week. Persons above 60 suffered from the cold, as the excess of deaths at that age demonstrated; while in childhood and manhood the mortality was below the average. Females suffered to a greater extent than males; the deaths of 502 females, and 465 males, having been registered. This ratio is usually the reverse, or 520 males to 493 females. Neither small-pox, measles, hooping cough, typhus, nor any other epidemic disease, except scarlet fever, is prevailing; and the epidemic of scarlet fever is subsiding. Pneumonia is less fatal than it was a month ago; but asthma, and dropsy, commonly connected with disease of the heart, and difficult respiration, proved fatal to 97, while the weekly average (1838) was 68. Two women died in childbed; the weekly average (1838) was 8. Mortification proved fatal to 8, or double the weekly average (4); and the number of violent deaths, from drowning and other accidents, was increased by obvious causes.

The practical deductions, from these facts, need not be pointed out to medical readers.

Source

Farr, William. "On the 'Table of Mortality' for the Metropolis." *Lancet* 1. 856 (January 25, 1840): 652–656.

A Short Method of Constructing Life Tables
(1845)

The arithmetical labour involved in the construction of correct life tables, showing the living at every year of age, is very considerable. But for a great many purposes the number surviving every five years, after the five first, and the expectations of life at those intervals, furnish quite sufficient information. These results were obtained by employing the following method in calculating the life tables for the Metropolis, Surrey, and Liverpool:—

Up to the age of five years the method is the same as that already described, and it was thus found that of 50,521 boys born in Surrey, 43,637 live a year, 41,857 two years, 40,704 three years, 40,031 four years, 39,550 five years. The next point was to determine how many of the 39,550 attain the age of 10 years. The living enumerated at the age 5–10 were 13,588, the deaths 145; and after the proper correction the mortality *m* was ascertained to be .01050;

so $\frac{m}{2} = .00525$, and $\frac{1-\frac{1}{2}m}{1+\frac{1}{2}m} = \frac{.99475}{1.00525} = .98955$ the probability of living *one year* at the middle of the period, or at seven and a half years of age.

But it may be assumed that $\left(\frac{1-\frac{1}{2}m}{1+\frac{1}{2}m}\right)^5 = p_{5,5} =$ the probability of living the *five years* from the age of 5 to 10; and $(.98955)^5 = .94885$; which, multiplied by 39550, gives 37527 = the numbers surviving at the age of 10.

If the calculation be continued down to 15, 20, 25, and every fifth year to the end, the following table will be obtained:—

Add up the column headed, "living" to the number 39,550 (against the age 5 years), and the sum will be the number of five years—of *lustres*—which the 39,550 persons will live + $\frac{39{,}500}{2}$. Subtract, therefore, 19,775 from the sum 425,923, and 406,148 will remain; which, divided by 39,550, gives for quotient 10.269 *lustres* as the expectation of life at that age. A luster is five years; consequently the expectation of life in years is five times 10.269 or 51.3 years. If 425,923 be divided by 39,550, the quotient will be 10.769; and 10.769 − .5 = 10.269, the same result as before. The expectation of life will be found to be 34.5 years at the age of 30.

The number of living at every five years except the first, deduced by

Surrey Life Table—Males (1841)

Age	Living	Quinquennial Periods + ½lm.	Age	Living	Quinquennial Periods + ½lm.
0	50,521	476,444	40	29,822	179,047
		—	45	28,069	149,225
1	43,637	—	50	25,973	121,156
2	41,857	—	55	23,892	95,183
3	40,704	—	60	21,459	—
4	40,031	—	65	18,235	—
		—	70	13,976	—
5	39,550	425,923	75	9,836	—
10	37,527	386,373	80	5,393	—
15	36,469	348,846	85	2,031	—
20	35,338	312,377	90	290	—
25	34,061	277,039	95	58	—
30	32,742	242,978	100	11	
35	31,189	210,236	105	2	

this method, may be considered nearly correct; the expectation of life is slightly overstated by the assumption that the living at the ages 5, 6, 7, 8, 9, 10 and 10, 11, &c., are series in arithmetical progression. The error does not exceed one-tenth part of a year from 5 to 60 years of age. At birth, and after 70, it does not exceed half a year, which may be subtracted as a correction. But by calculating the number surviving every year up to the age of five, a sufficiently close approximation to the expectation of life at birth will be obtained. The years of life under five are $\frac{5}{6} \times 256{,}300 = 213{,}583$; and the years of life after the age of five = 5 × (425,923–19,775) = 2,030,740 and $\frac{2{,}030{,}740 + 213{,}583}{50{,}521} = 44.4$, a boy's expectation of life at birth in Surrey. A life table still shorter may be constructed by taking intervals of 10 years, and using $\left(\frac{1 - \frac{1}{2}m}{1 + \frac{1}{2}m}\right)^{10}$. The errors in the calculation

Decennial Life Table—(From the English Table)

Years	Living	Expectation of Life
0	100,000	42.05 – .89 = 41.16
10	70,612	47.47 – .03 = 47.44
20	66,059	40.40 – .06 = 40.34
30	60,332	33.76 – .08 = 33.68
40	53,825	27.23 – .09 = 27.14
50	46,621	20.67 – .12 = 20.55
60	37,996	14.23 – .23 = 14.00
70	24,531	9.29 – .51 = 8.78
80	9,398	By the decennial table · Error · By the annual table
90	1,140	
100	16	

of the expectation of life from the living at every tenth year, can be corrected. They are always of the same nature. If we take the numbers "living" against every 10th year from the English Table, it will be found that the excess of the expectations of life, ranges at the ages 10 to 50, from .1 to .2 or .3 of a year. At birth the true expectation will be obtained very nearly by subtracting one year from the expectation, derived from the decennial table.

By adding up the column headed "living," in the subjoined table, dividing by the first number 100,000, multiplying by 10, and subtracting 5, we obtain 42.05 years as the expectation of life, which is too much by nine-tenths of a year.

$$\text{Age } 0\ \frac{470{,}530}{100{,}000} \times 10 = 47.05;\ \textit{and}\ 47.05 - 5 = 42.05$$

True expectation of life <u>41.16</u>
Error .89

$$\text{Age } 10\ \frac{370{,}530}{70{,}612} \times 10 = 52.47;\ \text{and}\ 52.47 - 5 = 47.47$$

True expectation of life <u>47.44</u>
Error .03

(5th Annual Report, pp. 362–5.)

Source

Farr, William. *Vital Statistics: A Memorial Volume of Selections From the Reports and Writings of William Farr, MD, DCL, CB, FRS, Late Superintendent of the Statistical Department of the Registrar General's Office, England.* London: Offices of the Sanitary Institute, 1885. Reprinted for the New York Academy of Medicine. Metuchen, NJ: Scarecrow Press, 1975.

CHAPTER 9

EDWIN CHADWICK
(1800–1890)

It was the best of times, it was the worst of times.

—Charles Dickens, *A Tale of Two Cities*, 1859

In the history of public health, it is difficult to find a more tragic figure than that of Edwin Chadwick. Chadwick's efforts on behalf of English public health were critical for the establishment of the field in Victorian Britain. Yet his abrasive manner and lack of political skills led to his marginalization as a force for the advancement of public health during his lifetime.

Born on January 24, 1800, in Manchester, England, to a successful businessman, Chadwick was raised in a home focused on education and enlightenment. At age 10 years, his family moved to London. Chadwick completed his secondary schooling and opted for a career in the law, supporting himself as a journalist. He joined the Utilitarian Society, where he met Jeremy Bentham, the chief philosopher/theologian of that movement. Bentham took notice of some of Chadwick's writings, and in a short time Chadwick secured a position as Bentham's personal secretary.

In 1832, the British government began an inquiry into the operation of the Poor Laws. These statutes, dating back to 1601, were a hodgepodge collection of laws focused on poverty relief. Chadwick was appointed assistant commissioner and tasked with investigating the operation of the Poor Laws in London. He wrote about one-third of the commission's final report, and many of its recommendations were incorporated into the Poor Law Amendment Act of 1834. The act established a board of three commissioners to supervise the operation of the Poor Laws throughout England. Chadwick was offered the secretary position, with the promise of considerable influence to address the problems he identified during his investigations.

An economic downturn in 1837 resulted in many persons seeking relief in workhouses. At the same time, typhoid fever and influenza epidemics hit England in succession. The government became concerned about the loss of laborers to epidemics as this could have dire consequences for the country's rapidly industrializing economy. Indeed, the loss of the laboring class during the

Black Plague during the fourteenth century was severe enough to restructure the economic order in Europe.

It was known that more people died in urban areas, but it was generally accepted that this was logical because the most deaths should occur where the most people lived. Chadwick conceptualized the problem differently, suggesting that elevated urban mortality was associated with endemic poverty, poor sanitation, and the presence of miasms ("bad air"). If one were to eliminate the unsanitary conditions, the health of the poor would improve, providing the laborers needed for the Victorian economy.

The government asked Chadwick to launch an inquiry that would both prove his contention and map a means of addressing the issue of poor sanitation. He responded with an exhaustive review of all available evidence on the effects of the Poor Laws on health in general and sanitation in particular. His resulting *Report on the Sanitary Condition* created quite a stir. At least 7,000 copies of the report circulated, in part because Chadwick sent multiple copies to each Poor Law administrative office. However, the Conservative government then in office did not act, a lack of impact Chadwick shared with his distant cousin Lemuel Shattuck when Shattuck presented his report to the Massachusetts legislature in 1849. Matters remained unchanged until the 1847 election returned the Liberals to the government. The landmark Public Health Act of 1848 resulted in the creation of a national General Board of Health. Chadwick persisted in trying to extend his reforms to Scotland, but his efforts were rejected in 1849 as Scottish physicians held different views on the causes of epidemics.

Chadwick served on the General Board of Health, but his efforts at sanitary reform were thwarted by entrenched interests, such as landlords who did not want to install running water and toilets on their properties, and his own quarrelsome personality. His hard-nosed bureaucratic approach to public health generated much ill will among the electorate. By 1854, it had become clear that the Public Health Act would not be renewed by Parliament if there were any chance of Chadwick's continued association with the General Board of Health. Accordingly, Chadwick agreed to leave his position with a lifetime pension of £1,000 per year. Public health activity then passed on to the newly created Privy Council, with John Simon serving as medical officer.

Chadwick died on July 6, 1890, having been little appreciated at that time. Today we recognize his report as having opened the door for the state to take responsibility for sanitary actions.

A Note on the Text

Chadwick's *Report on the Sanitary Condition of the Labouring Population of Great Britain* presents a catholic review of the public health ills of early Victorian society.

The report begins with a tabulation of data from William Farr (of the Registrar General's Office) regarding deaths from preventable causes in each county and comments on the associated costs. What follows is a description of every known inhabited space in Britain as seen by the sanitarian. Infrastructure was examined intimately. From Chadwick's viewpoint, the issue was simple—whether or not the country had the will to invest in making the necessary changes.

Upon completion of the *Report*, Chadwick took on the contentious issue of urban burials, a topic he has not previously covered owing to deference to another committee. *Interment in Towns* was published in 1843 as a 279-page supplement to the *Report*. Some feel this was possibly his finest work, probing more deeply than any previous investigation of this culturally sensitive but vitally important concern for public health.

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Report on the Sanitary Condition of the Labouring Population of Great Britain and On the Means of Its Improvement (1842, Abridged)

Gentlemen,—Since my special attention was directed to the inquiry as to the chief removable circumstances affecting the health of the poorer classes of the population, I have availed myself of every opportunity to collect information respecting them. In company with Dr. Arnott I visited Edinburgh and Glasgow, and inspected those residences that were pointed out by the local authorities as the chief seats of disease. I also visited Dumfries. An inspection of similar districts in Spitalfields, Manchester, Leeds, and Macclesfield, and inquiries formerly made under the Commission of Poor Law Inquiry,[1] and inspections of the condition of the residences of the poorer classes in parts of Berkshire, Sussex, and Hertfordshire,[2] had supplied me with means of comparison. Abandoning any inquiries as to remedies, strictly so called, or the treatment of diseases after their appearance, I have directed the examinations of witnesses and the reports of medical officers chiefly to collect information of the best means available as preventives of the evils in question. On the documentary evidence of the medical officers, and on the examinations of witnesses, aided by personal inspections, I have the honour to report as follows:—

Partial descriptions of the condition of the labouring classes, in respect to their residences and the habits which influence their health, afford but a faint conception of the evils which are the subject of inquiry. If only particular instances, or some groups of individual cases be adducted, the erroneous impression might be created that they were cases of comparatively infrequent occurrence. But the following tabular return made up from the registration of the causes of death in England and Wales, which is the most complete yet attained,[3] will give a sufficiently correct conception of the extent of the evils in question, when illustrated by the evidence of eye-witnesses, the medical officers whose duty it has been to attend on the spot and alleviate them. The table comprehends the abstract of the returns of the deaths from the chief diseases, which the medical officers consider to be the most powerfully influenced by the physical circumstances under which the population is placed—as the external and internal condition of their dwellings, drainage, and ventilation.

The registration of the causes of death for the year 1839 is selected, as that was the year when the report was made on the sanitary condition of the labouring population in the metropolis,[4] which has served as the foundation of the extended inquiry.

There are no returns, and no adequate data for returns, to show the proportion in which deaths from the several causes above specified occur amongst the population of Scotland,[5] but there is evidence to which reference will subsequently be made tending to prove that the mortality from fever is greater in Glasgow, Edinburgh, and Dundee than in the most crowded towns in England.

The registered mortality from all specified diseases in England and Wales was, during the year 1838, 282,940, or 18 per thousand of the population. These deaths are exclusive of the deaths from old age, which amounted to 35,564, and the deaths from violence, which amounted to 12,055. The deaths from causes not specified were 11,970. The total amount of deaths was 342,529 for that year. In the year following the total deaths were 338,979, of which the registered deaths from old age were 35,063, and the deaths from violence 11,980. The proportion of deaths for the whole population was 21 per thousand.

It appears that fever, after its ravages amongst the infant population, falls with the greatest intensity on the adult population in the vigour of life.[6] The periods at which the ravages of the other diseases, consumption, small-pox, and measles take place, are sufficiently well known. The proportions in which the diseases have prevailed in the several counties will be found deserving of peculiar attention.

A conception may be formed of the aggregate effects of the several causes of mortality from the fact, that of the deaths caused during one year in England and Wales by epidemic, endemic, and contagious diseases, including fever, typhus, and scarlatina, amounting to 56,461, the great proportion of which are proved to be preventible [*sic*], it may be said that the effect is as if the whole county of Westmoreland, now containing 56,469 souls or the whole county of Huntingdonshire, or any other equivalent district, were entirely depopulated annually, and were only occupied again by the growth of a new and feeble population living under the fears of a similar visitation. The annual slaughter in England and Wales from preventible causes of typhus which attacks persons in the vigour of life, appears to be double the amount of what was suffered by the Allied Armies in the battle of Waterloo.[7] It will be shown that diseases such as those which now prevail on land, did within the experience of persons still living, formerly prevail to a greater extent at sea, and have since been prevented by sanitary regulations; and that when they did so prevail in ships of war, the deaths from them were more than double in

Counties	Number of Deaths during the Year ended 31st December, 1838, from										Proportion of Deaths from the preceding Causes in every 1,000 of the Population, 1841	Proportion of Deaths from all Causes of Mortality in every 1,000 of the Population, 1841
	Epidemic, Endemic, and Contagious Diseases				Diseases of Respiratory Organs			Diseases of Brain, Nerves, and Senses	Diseases of Digestive Organs	Total Deaths from the four preceding Classes of Diseases		
	Fever: Typhus, Scarlatina	Small-pox	Measles	Hooping Cough	Consumption	Pneumonia	All other Classes					
England												
Bedford	155	75	40	66	457	97	57	304	131	11,382	13	22
Berks	204	288	21	88	739	231	162	467	201	2,399	15	25
Bucks	256	85	61	27	575	131	61	348	152	1,696	11	19
Cambridge	231	136	57	90	686	156	70	318	189	1,933	12	21
Chester	592	279	178	87	1,742	366	345	1,442	421	5,452	14	21
Cornwall	443	135	168	491	1,270	342	124	631	228	3,832	11	18
Cumberland	165	188	11	83	562	75	142	278	169	1,673	9	21
Derby	394	77	79	71	905	200	205	777	268	2,976	11	18
Devon	615	460	287	312	1,649	564	298	1,237	471	5,893	11	18
Dorset	137	155	80	58	571	146	106	380	159	1,892	11	19

(continued)

(continued)

Counties	Number of Deaths during the Year ended 31st December, 1838, from										Proportion of Deaths from the preceding Causes in every 1,000 of the Population, 1841	Proportion of Deaths from all Causes of Mortality in every 1,000 of the Population, 1841
	Epidemic, Endemic, and Contagious Diseases				Diseases of Respiratory Organs			Diseases of Brain, Nerves, and Senses	Diseases of Digestive Organs	Total Deaths from the four preceding Classes of Diseases		
	Fever: Typhus, Scarlatina	Small-pox	Measles	Hooping Cough	Consumption	Pneumonia	All other Classes					
Durham	347	316	139	304	1,009	362	207	1,138	274	4,094	13	21
Essex	417	460	83	163	1,250	276	234	782	268	3,933	11	19
Gloucester	352	457	440	244	1,395	578	476	1,142	510	5,594	13	20
Hereford	4	83	17	36	333	56	57	238	62	966	8	18
Hertford	160	116	45	48	620	107	90	453	155	1,794	11	20
Huntington	61	18	1	17	216	45	42	140	72	612	10	18
Kent	955	510	169	214	1,701	564	526	1,650	651	6,940	13	21
Lancaster	2,866	1,628	898	910	8,124	2,660	1,916	7,457	3,231	26,690	18	25
Leicester	273	98	17	70	941	243	154	668	314	2,778	13	21
Lincoln	370	138	29	88	874	248	242	1,090	358	3,437	9	17
Middlesex	4,422	3,359	487	1,749	6,220	3,097	2,334	6,643	2,492	30,803	20	27
Monmouth	328	321	49	91	481	183	78	550	100	2,181	16	24

Norfolk	515	126	63	109	1,388	325	281	793	395	3,995	10	19
Northhampton	348	148	36	36	762	192	124	503	212	2,361	12	21
Northumber land	366	149	46	113	715	287	240	709	388	3,013	12	21
Nottingham	222	73	18	80	911	225	201	901	287	2,918	12	20
Oxford	222	81	51	59	655	108	152	389	180	1,897	12	21
Rutland	11	2	–	13	64	14	8	56	28	196	9	17
Salop	213	154	112	138	995	242	168	550	284	2,856	12	21
Somerset	560	710	401	46	1,446	426	373	982	473	5,417	12	21
Southampton	454	164	78	148	1,222	338	331	881	372	3,988	17	19
Stafford	610	249	182	268	1,809	539	419	1,251	597	5,924	12	18
Suffolk	480	325	53	158	1,306	315	184	538	275	3,634	12	20
Surrey	1,348	814	177	565	2,196	978	700	2,325	763	9,866	11	25
Sussex	391	80	159	88	1,047	222	181	863	295	3,326	11	18
Warwick	454	415	153	164	1,495	678	361	978	638	5,336	13	20
Westmoreland	41	40	6	41	248	33	44	154	46	653	12	21
Wilts	246	259	263	140	869	268	212	606	241	3,104	12	20
Worcester	381	305	122	258	990	353	235	645	446	3,735	16	29

(continued)

(*continued*)

Counties	Number of Deaths during the Year ended 31st December, 1838, from										Proportion of Deaths from the preceding Causes in every 1,000 of the Population, 1841	Proportion of Deaths from all Causes of Mortality in every 1,000 of the Population, 1841
	Epidemic, Endemic, and Contagious Diseases				Diseases of Respiratory Organs			Diseases of Brain, Nerves, and Senses	Diseases of Digestive Organs	Total Deaths from the four preceding Classes of Diseases		
	Fever: Typhus, Scarlatina	Small-pox	Measles	Hooping Cough	Consumption	Pneumonia	All other Classes					
York, E.R.	194	92	167	149	725	194	176	1,009	251	2,957	13	21
York, N.R.	123	28	69	114	550	102	135	553	187	1,861	9	17
York, W.R.	1,298	993	799	507	4,256	1,202	848	4,374	1,494	15,768	14	21
WALES												
North	660	575	4	210	1,227	102	223	1,311	198	4,510	13	18
South	1,613	1,004	199	398	1,834	129	277	1,200	380	7,034	14	21
TOTAL, 1838	**24,577**	**16,268**	**6,514**	**9,107**	**59,025**	**17,999**	**13,799**	**49,704**	**19,306**	**216,299**	**14**	**22**
TOTAL, 1839	**25,991**	**9,131**	**10,937**	**8,165**	**59,559**	**18,151**	**12,855**	**49,215**	**20,767**	**214,771**	**14**	**21**

amount of the deaths in the battle. But the number of persons who die is to be taken also as the indication of the much greater number of persons who fall sick, and who, although they escape, are subjected to the suffering and loss occasioned by attacks of disease. Thus it was found on the original inquiry in the metropolis, that the deaths from fever amounted to 1 in 10 of the number attacked. If this proportion held equally throughout the country, then a quarter of a million of persons will have been subjected to loss and suffering from an attack of fever during the year; and in so far as the proportions of attacks to deaths is diminished, so it appears from the reports is the intensity and suffering from the disease generally increased. It appears that the extremes of mortality at the Small-pox Hospital, in London, amongst those attacked, have been 15 per cent. and 42 per cent. But if, according to other statements, the average mortality be taken at 1 in 5, or 20 per cent., the number of persons attacked in England and Wales during the year of the return, must amount to upwards of 16,000 persons killed, and more than 80,000 persons subjected to the sufferings of disease, including, in the case of the labouring classes, the loss of labour and long-continued debility; and in respect to all classes, often permanent disfigurement, and occasionally the loss of sight.

In a subsequent part of this report, evidence will be adduced to show in what proportion these causes of death fall upon the poorer classes as compared with the other classes of society inhabiting the same towns or compared with the other classes of society inhabiting the same towns or districts, and in what proportions the deaths fall amongst persons of the same class inhabiting districts differently situated.

The first extracts present the subjects of the inquiry in their general condition under the operation of several causes, yet almost all will be found to point to one particular, namely, atmospheric impurity, occasioned by means within the control of legislation, as the main cause of the ravages of epidemic, endemic, and contagious diseases among the community, and as aggravating most other diseases. The subsequent extracts from the sanitary reports from different places will show that the impurity of its evil consequences are greater or less in different places, according as there is more or less sufficient drainage of houses, streets, roads, and land, combined with more or less sufficient means of cleansing and removing solid refuse and impurities, by available supplies of water for the purpose. Then will follow the description of the effects of overcrowding the places of work and dwellings, including the effects of the defective ventilation of dwelling-houses, and of places of work where there are fumes or dust produced. To these will be added the information collected as to the good or evil moral habits promoted by the nature of the residence. These will form so many successive sections of the report, and will be followed by information in respect to the means available for the prevention of the evils described, and an exposition of the present state of the law for the protection of the public health, and of modifications apparently requisite to secure the desired results.

[Sections I through VIII continue for 340 pages, including extensive quotes from other reports and testimony from physicians and local authorities. Topics of discussion include the condition of housing and roads, clean water, and drainage. Domestic habits, family mismanagement, and crowding are also covered, and there is an extensive section on the differences in health among the classes. The last one-third covers the responsibilities of employers, the role of legislation, and responsibility of local authorities. The *Report* concludes with Section IX, below. Ed.]

IX
Recapitulation of Conclusions

The last cited instance of the practical operation of measures for the abatement of the nuisances attendant on common lodging-houses may also be submitted as an instance of the advantages derivable from the extension of such fields of inquiries as the present. On each of the chief points included in it there would have been a loss of what I hope will be deemed valuable corroborative information, had the inquiry been confined either to England or to Scotland. The observation of the important productive use of the refuse of the city of Edinburgh would have been of comparatively little value as evidence leading to practical applications, apart form the observation of what is accomplished by the practical application of science to sewerage and drainage for the immediate and cheapest removal of all the refuse in towns by water through closed drains afforded by the operation in the Holborn and Finsbury division of the metropolis. It may be stated confidently that, if the inquiry could conveniently have had still further extension as to time and place, the information would have been strengthened and rendered more complete. From incidental facts I have met with, I am led to believe that the whole of the effects which are subject of the present report would have been still more strikingly displayed in many parts of Ireland.

After as careful an examination of the evidence collected as I have been enabled to make, I beg leave to recapitulate the chief conclusions which that evidence appears to me to establish.

. . . *First, as to the extent and operation of the evils which are the subject of the inquiry:—*

That the various forms of epidemic, endemic, and other disease caused, or aggravated, or propagated chiefly amongst the labouring classes by atmospheric impurities produced by decomposing animal and vegetable substances, by damp and filth, and close and overcrowded dwellings prevail amongst the population in every part of the kingdom, whether dwelling in separate houses, in rural villages, in small towns, in the larger towns—as they have been found to prevail in the lowest districts of the metropolis.

That such disease, wherever its attacks are frequent, is always found in connexion with the physical circumstances above specified, and that where those circumstances are removed by drainage, proper cleansing, better ventilation, and other means of diminishing atmospheric impurity, the frequency and intensity of such disease is abated; and where the removal of the noxious agencies appears to be complete, such disease almost entirely disappears.

That high prosperity in respect to employment and wages, and various and abundant food, have afforded to the labouring classes no exemptions from attacks of epidemic disease, which have been as frequent and as fatal in periods of commercial and manufacturing prosperity as in any others.

That the formation of all habits of cleanliness is obstructed by defective supplies of water.

That the annual loss of life from filth and bad ventilation are greater than the loss from death or wounds in any wars in which the country has been engaged in modern times.

That of the 43,000 cases of widowhood, and 112,000 of destitute orphanage relieved from the poor's rates in England and Wales alone, it appears that the greatest proportion of deaths of the heads of families occurred from the above specified and other removable causes; that their ages were under 45 years; that is to say, 13 years below the natural probabilities of life as shown by the experience of the whole population of Sweden.

That the public loss from the premature deaths of the heads of families is greater than can be represented by an enumeration of the pecuniary burdens consequent upon their sickness and death.

That, measuring the loss of working ability amongst large classes by the instances of gain, even from incomplete arrangements for the removal of noxious influences from places of work or from abodes, that this loss cannot be less than eight or ten years.

That the ravages of epidemics and other diseases do not diminish but tend to increase the pressure of population.

That in the districts where the mortality is the greatest the births are not only sufficient to replace the numbers removed by death, but to add to the population.

That the younger population, bred up under noxious physical agencies, is inferior in physical organization and general health to a population preserved from the presence of such agencies.

That the population so exposed is less susceptible of moral influences, and the effects of education are more transient than with a healthy population.

That these adverse circumstances tend to produce an adult population short-lived, improvident, reckless, and intemperate, and with habitual avidity for sensual gratification.

That these habits lead to the abandonment of all the conveniences and decencies of life, and especially lead to the overcrowding of their homes, which is destructive to the morality as well as the health of large classes of both sexes.

That defective town cleansing fosters habits of the most abject degradation and tends to the demoralization of large numbers of human beings, who subsist by means of what they find amidst the noxious filth accumulated in neglected streets and bye-places.

That the expenses of local public works are in general unequally and unfairly assessed, oppressively and uneconomically collected, by separate collections, wastefully expended in separate and inefficient operations by unskilled and practically irresponsible officers.

That the existing law for the protection of the public health and the constitutional machinery for reclaiming its execution, such as the Corts Leet, have fallen into desuetude, and are in the state indicated by the prevalence of the evils they were intended to prevent.

Secondly. As to the means by which the present sanitary condition of the labouring classes may be improved:—

The primary and most important measures, and at the same time the most practicable, and within the recognized province of public administration, are drainage, the removal of all refuse of habitations, streets, and roads, and the improvement of the supplies of water.

That the chief obstacles to the immediate removal of decomposing refuse of towns and habitations have been the expense and annoyance of the hand labour and cartage requisite for the purpose.

That this expense may be reduced to one-twentieth or to one-thirteenth, or rendered inconsiderable, by the use of water and self-acting means of removal by improved and cheaper sewers and drains.

That refuse when thus held in suspension in water may be most cheaply and innoxiously conveyed to any distance out of towns, and also in the best form for productive use, and that the loss and injury by the pollution of natural streams may be avoided.

That for all these purposes, as well as for domestic use, better supplies of water are absolutely necessary.

That for successful and economical drainage the adoption of geological areas as the basis of operations is requisite.

That appropriate scientific arrangements for public drainage would afford important facilities for private land-drainage, which is important for the health as well as sustenance of the labouring classes.

That the expense of public drainage, of supplies of water laid on in houses, and of means of improved cleansing would be a pecuniary grain, by diminishing the existing charges attendant on sickness and premature mortality.

That for the protection of the labouring classes and of the ratepayers against inefficiency and waste in all new structural arrangements for the protection of the public health, and to ensure public confidence that the expenditure will be beneficial, securites [*sic*] should be taken that all new local public works are devised and conducted by responsible officers qualified by the possession of the science and skill of civil engineers.

That the oppressiveness and injustice of levies for the whole immediate outlay on such works upon persons who have only short interests in the benefits may be avoided by care in spreading the expense over periods coincident with the benefits.

That by appropriate arrangements, 10 or 15 per cent. on the ordinary outlay for drainage might be saved, which on an estimate of the expense of the necessary structural alterations of one-third only of the existing tenements would be a saving of one million and a half sterling, besides the reduction of the future expenses of management.

That for the prevention of the disease occasioned by defective ventilation, and other causes of impurity in places of work and other places where large numbers are assembled, and for the general promotion of the means necessary to prevent disease, that it would be good economy to appoint a district medical officer independent of private practice, and with the securities of special qualifications and responsibilities to initiate sanitary measures and reclaim the execution of the law.

That by the combinations of all these arrangements it is probable that the full ensurable period of life indicated by the Swedish tables; that is, an increase of 13 years at least, may be extended to the whole of the labouring classes.

That the attainment of these and the other collateral advantages of reducing existing charges and expenditure are within the power of the legislature, and are dependent mainly on the securities taken for the application of practical science, skill, and economy in the direction of local public works.

And that the removal of noxious physical circumstances, and the promotion of civic, household, and personal cleanliness, are necessary to the improvement of the moral condition of the population; for that sound morality and refinement in manners and health are not long found co-existant [*sic*] with filthy habits amongst any class of the community.

I beg leave further to suggest, that the principles of amendment deduced from the inquiry will be found as applicable to Scotland as to England; and if so, it may be submitted for attention whether it might not be represented that the structural arrangements for drainage would be most conveniently carried out in the same for as in England, that is by commissions, of the nature of commission of sewers adapted, as regards jurisdiction to natural or geological areas, and including in them the chief elected officers of municipalities, and other authorities now charged with the care of the streets and roads or connected with local public works.

The advantages of uniformity in legislation and in the executive machinery, and of doing the same things in the same way (choosing the best), and calling the same officers, proceedings, and things by the same names, will only be appreciated by those who have observed the extensive public loss occasioned by the legislation for towns which makes them independent of beneficent [*sic*], as of what perhaps might have been deemed formerly aggressive legislation. There are various sanitary regulations, and especially those for cleansing, directed to be observed in 'every town except Berwick and Carlisle;' a course of legislation which, had it been efficient for England, would have left Berwick and Carlisle distinguished by the oppression of common evils intended to be remedied. It was the subject of public complaint, at Glasgow and in other parts of Scotland, that independence and separation in the form of general legislation separated the people from their share of the greatest amount of legislative attention, or excluded them from common interest and from the common advantages of protective measures. It was, for example, the subject of particular complaint, that whilst the labouring population of England and Ireland had received the advantages of public legislation for a general vaccination, the labouring classes in Scotland were still left exposed to the ravages of the small-pox. It was also complained by Dr. Cowan and other members of the medical profession, that Scotland had not been included in the provisions for the registration of the causes of death which they considered might, with improvements, be made highly conducive to the advancement of medical science and the means of protecting the public health.

I have the honour to be,
Gentlemen,
Your obedient servant,
EDWIN CHADWICK

SOURCE

Chadwick, Edwin. *Report on the Sanitary Condition of the Labouring Population of Great Britain*. Edited by M. W. Flinn. Edinburgh: University Press, 1965.

A Supplementary Report on the Results of a Special Inquiry into the Practice of Interment in Towns (1843)

[This 279-page report begins with extensive letters and interviews of anatomists, physicians, and undertakers from throughout England, as well as from the United States, France, and Germany, in order to define the public health problems related to burials in towns. The report includes discussions of the practices of the poor who keep bodies in their homes for extended periods, testimony from those who note the poor quality of surface water where burials are dense, and a laying bare of the practice of churches that bury layers of persons within churchyards as a moneymaking endeavor. Ed.]

. . . Mr. Leonard, surgeon and medical officer of the parish of St Martin's-in-the-Fields, gives the following instances of the circumstances in which the poorest class of inhabitants die, which may be adduced as exemplifications of the dreadful state of circumstances in which the survivors are placed for the want of adequate accommodation for the remains immediately after death, and previous to the interment:—

> There are some houses in my district that have from 45 to 60 persons of all ages under one roof, and in the event of death, the body often occupies the only bed till they raise money to pay for a coffin, which is often several days. . . . Of course the tenants are *never free from fevers* and diarrhoea and the mortality is great. The last class live, for the most part, in lodging houses, where shelter is obtained, with a bed of straw, for 2d to 4d per night, and where this is not obtainable, the arches under the Adelphi afford a shelter. In the lodging-rooms I have seen the beds placed so close together as not to allow room to pass between them, and occupied by both sexes indiscriminately. I have known six people sleep in a room about nine feet square, with only one small window, about 17 inches by 12 inches; and there are some sleeping rooms in this district in which you cannot scarcely see your hand at noonday.
>
> *How long is the dead body retained in the room beside the living?*—If the person has subscribed to a club, or the friends are in circumstances to afford the expense of the funeral, it takes place, generally, on the following Sunday, if the death has occurred earlier in the week; but if towards the end of the week, then it is sometimes postponed till the Sunday week after, if the weather permit; in one case it was twelve days. . . .

> *In what condition is the corpse usually, or frequently, retained?*—Amongst the Irish, it does not signify of what disease the person may have died, it is retained often for many days, laid out upon the only bed, perhaps. . . . Thus fevers and other contagious diseases are fearfully propagated. . . . This spring I removed a girl, named Wilson, to the infirmary of the Workhouse, from a room in the same court. I could not remain two minutes in it; the horrible stench arose from a corpse which had died of phthisis twelve days before, and the coffin stood across the foot of the bed, within eighteen inches of it. This was a small room not above ten feet by twelve feet square, and a fire always in it, being (as in most cases of a like kind) the only one for sleeping, living and cooking in. . . .

§16. In the metropolis, on spaces of ground which do not exceed 203 acres, closely surrounded by the abodes of the living, layer upon layer, each consisting of a population numerically equivalent to a large army of 20,000 adults, and nearly 30,000 youths and children, is every year imperfectly interred. Within the period of existence of the present generation, upwards of a million of dead must have been interred in those same spaces.

§17. A layer of bodies is stated to be about seven years in decaying in the metropolis: to the extent that this is so, the decay must be by the conversion of the remains into a gas and its escape, as a miasma, of many times the bulk of the body that has disappeared.

§18. In some of the populous parishes, where, from the nature of the soil, the decomposition has not been so rapid as the interments, the place of burial has risen in height; and the height of many of them just have greatly increased but for surreptitious modes of diminishing it by removal, which, it must be confessed, has diminished the sanitary evil, though by the creation of another and most serious evil, in the mental pain and apprehensions of the survivors and feelings of abhorrence of the population, caused by the suspicion and knowledge of the disrespect and desecration of the remains of the persons interred.

§19. The claims to exemption in favour of burial-grounds which it is stated are not overcrowded would perhaps be most favourably considered by the examination of the practice of interment in the new cemeteries, where the proportion of interments to the space is much less.

§20. I have visited and questioned persons connected with several of these cemeteries in town and country, and I have caused the practice of interments in others of them to be examined by more competent persons. The inquiry brought forward instances of the bursting of some leaden coffins and the escape of mephitic vapour in the catacombs; the tapping of others to prevent similar casualties; injuries sustained by grave-diggers from the escapes of miasma on the re-opening of graves, and an instance was stated to me by the architect of one cemetery, of two labourers having been injured, apparently by digging amidst some impure water which drained from some graves. No precedent examination of the evils affecting the public health, that are incident to the practice of interment, appears to have been made, no precedent scientific or impartial investigation appears to have been thought necessary by the joint-stock companies, or the Committees of the House of Commons, at whose instance privileges were conferred upon the shareholders: no new precautionary measures or improvement, such as are in use abroad, appear consequently to have been introduced in them; the practice of burial has in general been simply removed to better looking, and in general, better situated places. The conclusion, however, from the examination of these places (which will subsequently be reverted to) is, that if most of the cemeteries themselves were in the midst of the population, they would, even in their present state, often contribute to the combination of causes of ill health in the metropolis and several of the larger towns.

§21. It has been considered that all danger from interments in towns would be obviated if no burials were allowed except at a depth of five feet. But bodies buried much deeper are found to decay; and so certain as a body has wasted or disappeared is the fact that a deleterious gas has escaped. In the towns where the graveyards and streets are paved, the morbific matter must be diffused more widely through the sub-soil, and escape with the drainage. If the interments be so deep as to impede escapes at the surface, there is only the greater danger of escape by deep drainage and the pollution of springs. . . .

As to the Remedies available for the Prevention or Mitigation of these Evils.

§248. That the most effectual and principal means for the abatement of the evils of interments are those sanitary measures which diminish the proportionate numbers of deaths and funerals, and increase the duration of life. §75 to §82, and the General Report, p. 370. [Not included here. Ed.] But—

§249. That on the several special grounds, moral, religious, and physical, and in conformity to the best usages and authorities of primitive Christianity, §177, and the general practice of the most civilized modern nations, the practice of interments in towns in burial places amidst the habitations of the living, and the practice of interment in churches, ought for the future, and without any exception of places or acception [*sic*] of persons, to be entirely prohibited. (§1 to §23.)

§250. That the necessities of no class of the population in respect to burial ought not be abandoned as sources of private emolument to commercial associations, but that national cemeteries of a suitable description ought to be provided and maintained (as to the material arrangements), under the direction of officers duly qualified for the care of the public health. (§126.)

§251. That for the avoidance of the pain, and moral and physical evil arising from the prolonged retention of the body in the rooms occupied by the living, and at the same time to carry out such arrangements as may remove the painful apprehensions of premature interments, institutions of houses for the immediate reception, and respectful and appropriate care of the dead, under superior and responsible officers, should be provided in every town for the use of all classes of the community. (§90 to §101.)

§252. That for the abatement of oppressive charges for funeral materials, decorations, and services, provision should be made (in conformity to successful examples abroad) by the officers having charge of the national cemeteries, for the supply of the requisite materials and services, securing to all classes, but especially to the poor, the means of respectable interment, at reduced and moderate prices, suitable to the station of the deceased, and the condition of the survivors. (§186, §115 to §120.)

§253. That for these purposes, and for carrying out the physical arrangements necessary for the protection of the public health in respect to the practice of interment, officers of health qualified by medical education and special knowledge should be appointed. (§233.)

§254. That in order to abate the apprehensions of premature interment, §92 to §96, to bring responsible aid and counsel, and protection within the reach of the most destitute survivors, §§121 and 122 and §198, to protect the people against continued exposure to ascertained and preventable causes of disease and death, the principle of the early appointment of searchers be revived, and no interment be allowed to take place without the verification of the fact and cause of death by the officer of health. (§123, 124, 125, 126, to §216.)

§255. That in all clear and well ascertained cases of deaths from immediately removable causes of disease and death, the officers of health be invested with summary powers, and be responsible for exercising them, for the removal of those causes, and for the protection of strangers from continued exposure and suffering from them.

§256. That the expenses of national cemeteries should be raised by loans bearing interest.

§257. That the repayment of the principal and interest should be spread over a period of [thirty years?]—and be charged as part of the reduced expenses for future interments.

§258. That all burial fees and existing dues be collected on interment, and form a fund from whence be paid the compensations which Parliament may award to such existing interests as it may be necessary to disturb, including the payment of the establishment charges, and the principal and interest of the money expended for the erection of new cemeteries; and that any surplus which may thereafter accrue may be applied to the means of improving the health of the living.

§259. That, on consulting the experience of those cities abroad where the greatest attention has been given to the arrangements for the protection of health connected with interments, it appears that by the appointment of medical officers, unencumbered by private practice, as officers of health, and qualified by the possession of appropriate science for the verification of the fact and causes of death, and by committing to them the regulation of the service of interments in national cemeteries the several defects above specified may be remedied, and that new and comparatively salubrious places of burial may be procured, together with appropriate religious establishments, wherein the funeral service may be better solemnized, and that the expense of funerals may be reduced, in the metropolis, at the least, to one-half of the existing amount, and full compensation be given to all who may have legitimate claims for compensation for losses on the alterations of the existing practice. (§219 to §225.)

§260. That the agency of properly qualified officers of health necessary for abating the evils of the practice of interments would also serve powerfully to promote the application of those sanitary measures which in some districts would, there is reason to believe, save more than their own pecuniary expense, merely in the diminished numbers combined with reduced expenses of funerals, consequent on the practical operation of comprehensive measures of sanitary improvement. (§201.)

§261. The advantages which the measures proposed offer to the classes who now stand most in need of a beneficent intervention, may be thus recapitulated. To take the poorest class: the labouring man would (in common with the middle and higher classes) gain, on the occasion of his demise, protection for his widow and surviving children, that is to say;

Protection from the physical evil occasioned by the necessity of the prolonged retention of his remains in the living and sleeping room:

Protection against extortionate charges for interment, and against the impositions of unnecessary, expensive, and unseemly funereal customs, maintained against the wishes of private individuals and families:

Protection and redress to his survivors or the living against any unfair or illegal practices, should any such have led to the death:

Protection against any discoverable causes of ill health, should any have attached to his abode or to his place of work:

Protection from the painful idea (by arrangements preventive of the possibility) of a premature interment:

Protection of the remains from profanation, either before or after interment:

Protection such as may be afforded by the information and advice of a responsible officer, of knowledge, and station, in the various unforeseen contingencies that occur to perplex and mislead the prostrate and desolate survivors on such occasions. (§191 to §207.) Added to these will be the relief from the prospect of interment in a common grave-yard or charnel, by the substitution of a public national cemetery, on which the mind may dwell with complacency, as a place in which sepulture may be made an honour and a privilege.

§262. The advantages derivable to the public at large have already been specified, in the removal of causes of pain to the feelings of the living connected with the common burial places; they would also gain in the several measures for protection against the causes of disease specified as within the province of an officer of the public health to remove; and they would also gain in the steps towards the creation of a science of the prevention of diseases, and in a better registration of the fact and the causes of death.

To use the words of a great Christian writer,—that all this, which constitutes the last office of the living, "to compose the body to burial," should be done, and that it should be done well and "gravely, decently, and charitable, we have the example of all civilized nations to engage us, and of all ages of the world to warrant:—so that it is against common honesty, and public fame and reputation not to do this office."

I would, in conclusion, beg leave to repeat and represent urgently that Her Majesty's Government, should only set hands to this great work, when invested with full powers to effect it completely: for at present there appears to be no alternative between doing it well or ill; between simply shifting the evil from the centre of the populous districts to the suburbs, and deteriorating them; fixing the sites of interments at inconvenient distances, forming numerous, separate, and weak, and yet enormously expensive, establishments; aggravating the expense, and physical and moral evils of the delay of interment; diminishing the solemnities of sepulture; scattering away the elements of moral and religious improvement, and increasing the duration and sum of the existing evils:—there appears to be no distinct or practicable alternative between these results and effecting such a change as, if zealously carried out, will soothe and elevate the feelings of the great bulk of the population, abate the apprehensions of the dying, influence the voluntary adoption of beneficial changes in the practice of obsequies; occasion an earlier removal of the dead from amidst the living to await interment and ensure the impressiveness of the funeral service, give additional securities against attempts on life, and trustworthy evidence of the fact of death, with the means of advancing the protection of the living against the attacks of disease; and at a reduced expense provide in well arranged national cemeteries places for public monuments, becoming the position of the empire amongst civilized nations.

I have the honour to be, Sir,
Your obedient servant,
EDWIN CHADWICK

SOURCE

Chadwick, Edwin. A Supplementary Report on the Results of a Special Inquiry into the Practice of Interment in Towns. *Parliamentary Papers*, XII (1843).

CHAPTER 10

JOHN SIMON
(1816–1904)

[F]ew plants will flourish in the denser districts of London, unless the air which conduces to their nourishment be previously filtered from its dirt.

—John Simon, 1849

John simon was born in london in 1816, the sixth of 14 children born to Louis Michael Simon, a member of the Stock Exchange, and Matilde Nonnet. John attended preparatory school at Pentonville, private school at Greenwich, and Rhenish, Germany, where he mastered German and prepared for the medical profession. In 1833, he apprenticed as a surgeon, becoming a member of the Royal College of Surgeons in 1838.

Simon was known for his literary ability, culture, and fine tastes. In 1844 he won the first Astley-Cooper prize for an essay on the thymus gland, gaining him recognition and election to fellow in the Royal Society at the age of 29. In 1848, Simon married Jane O'Meara. The couple had no children, but they were socially prominent, not only with professional and medical contacts but in literary and artistic circles.

In 1848, Simon was appointed first medical officer of the General Board of Health for the city of London. He set to work presenting a series of reports on sewers to the City Commissioners, which were later reprinted in their entirety. By 1855 the General Board of Health was subject to annual renewals of its powers, weakened in purpose and stability. The board was abolished and its duties reassigned under the Public Health Act of 1858, with Simon becoming medical officer of the Privy Council. Simon made several valuable and comprehensive reports during this period of his service: on the relation of cholera to the London water supply (1856), on vaccination (1857), on the sanitary state of the people of England (1858), and on the constitution of the medical profession (1858).

As medical officer of the Privy Council, Simon instituted a series of annual reports covering the workings of his department. The reports included a series of special subjects presented with a broad public health outlook but written in a terse style and with graphic examples. During this period (1858–1871) Simon was implicitly trusted by his superiors and rallied together his fellow co-workers, who worked wholeheartedly for the public good. In 1871, various public health authorities (the old Poor Law Board, the Local Government Act Office of the Home Office, and the medical department of the Privy Council) were amalgamated to form one new department, the Local Government Board. Simon became chief medical officer of the new board in the belief that his independent powers would continue. When this was not to be, Simon protested vigorously. The result was that his office was ultimately abolished, and Simon retired in May 1876 at less than 60 years old.

Continuing to be energetic and dedicated to improving the public's health, Simon was made a crown member of the medical council, where he remained until his resignation in 1895. In 1881 he was president of the state medicine section of the International Medical Congress held in London. He took an active part in the affairs of the Royal College of Surgeons: from 1868 to 1880, he was one of the college council; from 1876 to 1878, he was vice president; and during 1878 to 1879, he acted as president. He also filled various honorary offices in professional societies. In 1887, on the occasion of Queen Victoria's first jubilee, he was knighted. At the end of his career he received the first award of two medals that had been founded for the purpose of recognizing eminence in sanitary science—the Harben medal of the Royal Institute of Public Health (1896) and the Buchanan medal of the Royal Society (November 1897). He died at his home in 1904 and was buried at Lewisham Cemetery, Ladywell. A bust of Simon was executed by Thomas Woolner in 1876, and it resides at the Royal College of Surgeons.

Among Simon's principal achievements, two stand out. The first was his supervision of measures taken in 1866 to enhance public sanitation, including the provision of clean drinking water and safe sanitary disposal; the second was the establishment of the General Medical Council, the licensing body for medical practitioners in the United Kingdom. His work on sanitary science and public health practice made Britain the world leader in public health in the late nineteenth century. His books include two classics of public health, *Public Health Reports* (1887) and *English Sanitary Institutions* (1890).

A Note on the Text

Simon's chief reports and writings on sanitary subjects were issued collectively by subscription by the Sanitary Institute of Great Britain. The preface to *Public Health Reports* sums up Simon's efforts as "fundamental" to the practice of sanitary science and recognizes their relevance to the social issues of the time:

> As was stated in the Prospectus which was issued by the Institute: "The work which Mr. Simon has performed (like that of Dr. Farr) is fundamental. It

has assisted materially to promote the success which in recent years has attended the action of Sanitary Authorities, viz., limiting the extension of all kinds of disease. His writings, like those of Dr. Farr, are distributed in a mass of blue books and reports, several of which are out of print, and they are not in a form which can be easily consulted by the student. Many of the papers are of immense importance at this juncture, when various social questions, connected with the housing of the poor and the occupations and feeding of the people, are coming into the field of practical politics."

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Excerpts from City of London Medical Reports (1849, 1850, 1852, Abridged)

Preface to City of London Medical Reports (1854)

This national prevalence of sanitary neglect is a very grievous fact. . . . I would beg any educated person to consider what are the conditions in which alone animal life can thrive; to learn, by personal inspection, how far those conditions are realized for the masses of our population; and to form for himself a conscientious judgment as to the need for great, if even almost revolutionary, reforms.

Let any such person devote an hour to visiting some very poor neighbourhood in the metropolis, or in almost any of our large towns. Let him breathe its air, taste its water, eat its bread. Let him think of human life struggling there for years. Let him fancy what it would be to himself to live there, in that beastly degradation of stink, fed with such bread, drinking such water. Let him enter somehow spare at hazard, and—heeding where he treads, follow the guidance of his outraged nose, to the yard (if there be one) or the cellar. Let him talk to the inmates; let him hear what is thought of the bone-boiler next-door; what of the Irish basket-makers upstairs—twelve in a room, who came in after the hopping, and got fever; what of the artisan's dead body, stretched on his widow's one bed, beside her living children.

Let him, if he have a heart for the duties of manhood and patriotism, gravely reflect whether such sickening evils, as an hour's inquiry will have shown him, ought to be the habit of our labouring population; whether of the Legislature, which his voice helps to constitute, is doing all that might be done to palliate those wrongs; whether it be not a jarring discord in the civilization we boast—of worse than pagan savageness in the Christianity we profess, that such things continue, in the midst of us, scandalously neglected; and that the interests of human life, except against willful violence, are almost uncared for by the law.

. . . Against *adulterations of food*, here and there, obsolete powers exist, for our ancestors had an eye to those things; but, practically, they are of no avail. If we, who are educated, habitually submit to have copper and our preserves, read—lead in our cayenne, alum in our bread, pigments in our tea, and ineffable nastiness in our fish-sauce, what can we expect of the poor? Can they use galactometers [to detect the dilutions of milk]? Can they test their pickles with ammonia? Can they discover the tricks by which bread is made dropsical (a chief artifice in the cheapening of bread is to increase its weight by various means which render it retentive of water), or otherwise deteriorated in the value, even faster than they can cheapening it in price? Without entering on details of what might be the best organization against such things, I may certainly assume it is greatly a *desideratum*, that local authorities should uniformly have power to deal with these frauds (as, of course, with every sale of decayed and corrupted food) and that they should be enabled to employ skilled officers, for detecting at least every adulteration of bread and every poisonous admixture in condiments and the like.

In some respects this sort of protection is even more necessary, as well as more deficient in regard to the *falsification of drugs*. The College of Physicians and the Apothecaries' Company are supposed to exercise supervision in the matter; so that at least its necessity is recognized by the law. The security thus afforded is, in practice, null. It is notorious in my profession that there are not many simple drugs, and still fewer compound preparations, on the standard strength the late of which we may reckon. It is notorious that some standard medications are so often falsified in the market, and others so often mis-made in the laboratory, that we are robbed of all certainty in their employment. Iodide of potassium—an invaluable specific, may be shammed to half its weight with the carbonate of potash. Scammoney, one of our best purgatives, is rare without chalk or starch, weakening it, perhaps, to half the intention of the giver. Cod-liver oil may have come from seals or from olives. The two or three drops of prussic acid that we should give for a dose may be nearly twice as strong at one chemist's as at another's. . . .

Again, with the *promiscuous sale of poisons*, what incredible laxity of government! One poison, indeed, has its one law. Arsenic may not be sold otherwise then coloured, nor except with full registration of the sale, and in the presence of a witness known to both buyer and vender. Admirable, as far as it goes! But why should arsenic alone receive this dab of legislation? Is the principal right, the means of murder and suicide should be rendered difficult of access for criminal purposes? Does anyone question it? Then, why not legislate equally against all poisons?—against oxalic acid and opium, corrosive sublimate, strychnine?

Nor can our past legislators be more boastful of their labours for the *medical profession*—either for its scientific interests, or for the public protection against ignorance and quackery. Nearly two dozen corporate bodies within the United Kingdom are said to grant licenses for medical practice; and I hardly know whether it lessens or aggravates this confusion, that such licenses are in many cases partial;—that one licentiate may practise north of the Tweed, but nowise to the South; that one may practise in London, another only seven miles beyond it. Not that the license seems much to matter! For innumerable poachers in all directions trespass on what the law purports to sell as a secured preserve for qualified practitioners; their encroachments are made with almost certain impunity; and—as for the titles of the profession, any impostor may style himself *doctor* or *surgeon* at his will. . . .

Having said so much on the defects and the wrongs of power in existing sanitary condition, perhaps I may venture to speak of the almost obvious remedy. "Almost obvious" I say; for surely no one will doubt that this great subject should be dealt with by comprehensive and scientific legislation; and I hardly see how otherwise, then that it should be submitted in its entirety to some single department of the executive, as the sole charge; that there should be some tangible head, responsible—not only for the *enforcement* of existing laws . . . but likewise for their *progress* from time to time to the level of contemporary science. . . . As regardless its constituted head, sitting in Parliament ("a minister of Public Health") his department should be, in the widest sense, to *care for the physical necessities of human life*. . . . [J.S.]

City Medical Report No. 1, 1849
Water Supply

I am sure that I do not exaggerate the sanitary importance of water, when I affirm that its restricted supply is the first essential of decency, of comfort, and of health; that no civilization of the poorer classes can exist without it; and that any limitation to its use in the metropolis is a barrier, which must maintain thousands in a state of the most unwholesome filth and degradation.

In the City of London the supply of water is but a fraction of what it should be. Thousands of the population have no supply of it to the houses where they dwell. For their possession of this first necessary of social life, such persons wholly depend on their power of attending at some fixed hour of the day, pail in hand, beside the nearest standcock; where, with their neighbours, they wait their turn—sometimes not without a struggle, during the tedious dribbling of a single small pipe. Sometimes there is a partial improvement on this plan; a group of houses will have a butt or cistern for the common use of some scores of inmates, who thus are saved the necessity of waiting at a standcock, but who still remain most insufficiently supplied with water. Next in the scale of improvement we find water-pipes laid on to the houses; but the water is turned on only for a few hours in the week, so that all who care to be adequately supplied with it must be provided with very spacious receptacles. Receptacles are sometimes provided: and in these, which are often of the most objectionable description, water is retained for the purposes of diet and washing, during a period of which varies from twenty-four to seventy-two hours. One of the most important purposes of a water-supply seems almost wholly abandoned—that, namely, of having a large quantity daily devoted to cleanse and clear the house-drains and sewers; and in many cases where a waste-pipe has been conducted from the water-butt to the privy, the arrangement is one which gives to the drainage little advantage of water, while it communicates to the water a well-marked flavour of drainage.

I consider the system of intermittent water-supply to be radically bad; not only because it is a system of stint in what ought to be lavishly bestowed, but also because of the necessity which it creates that large and extensive receptacles should be provided, and because of the liability to contamination incurred by water which has to be retained often during a considerable period. In inspecting the courts and alleys of the City, one constantly sees butts, for the reception of water, either public, or in the open yards of the houses, or sometimes in their cellars; and these butts, dirty, mouldering, and coverless; receiving soot and all other impurities from the air; absorbing stench from the adjacent cesspool; inviting filth from insects, vermin, sparrows, cats, and children; their contents often augmented through a rain water-pipe by the washings of the roof, and every hour becoming fustier and more offensive. Nothing can be less like what water should be than the fluid obtained under such circumstances; and one hardly knows whether this arrangement can be considered preferable to the precarious chance of scuffling or dawdling at the standcock. It may be doubted, too, whether, even in a fare better class of houses, the tenants' water supply can be pronounced good. The cisternage is better, and all arrangements connected with it are generally such as to protect it from the grosser impurities which defile the water-butts of the poor; but the long retention of water in leaden cisterns impairs its fitness for drinking; and the quantity which any moderate cistern will contain is very generally insufficient for the legitimate requirements of the house during the intervals of supply. Every one who is personally familiar with the working of this system of intermittent supply can testify to its inconvenience; and though its evils press with immeasurable greater severity on the poor than on the rich, yet the latter are by no means without experience on the subject.

The following are the chief conditions in respect of water supply, which peremptorily [*sic*] require to be fulfilled:—

1. That every house should be separately supplied with water, and that where the house is a lodging-house, or where the several floors are let as separate tenements, the supply of water should extend to each inhabited floor;
2. That every privy should have a supply of water, applicable as often as it may be required, and sufficient in volume to effect, at each application, a thorough flushing and purification of the discharge-pipe of the privy;

3. That every court, at the point remotest from the sewer-grating, there should be a standcock for the cleansing of the court; and
4. That at all these points there should always and uninterruptedly be a sufficiency of water to fulfil [*sic*] all reasonable requirements of the population.

Now, if my statements are accurate with regard to the imperfect manner in which thousands participate in the distribution of water, even for their personal necessities; if my statements are again accurate with respect to house-drainage, and to the immense increase of water distribution which must accompany any improvement in this respect—and I am quite prepared, if necessary, to adduce ample evidence on these subjects; if, again, it be considered that the appreciation of water by the multitude, who have so long suffered from lack of it, will lead to a vast augmentation of its domestic use; then, I apprehend it cannot be doubted that the subject of water-supply to the City is one that requires now to be looked at almost as though it were to-day broached for the first time.

Those important conditions, which I just enumerated as urgently requiring fulfillment, may certainly be accomplished, so far as mechanical construction is concerned, in more than one way. It may be possible, no doubt, in further compliance with the principle of intermittent supply, to furnish every tenement in the City with a cistern of proper dimensions, and with its usual appurtenances of ballcock, waste-pipe, &c.; but this, I need hardly say, would be a process involving a vast expenditure of money, and hardly to be recommended on the mere ground of conformity with what has hitherto been done in the matter. It may be possible, on the other hand, to convert the whole water-supply of the City into a system of uninterrupted supply, and to construct all new works in conformity with this system.

I beg to suggest that the choice between these alternatives is one of immense and very urgent importance to the sanitary welfare of the City; and I would earnestly commend it to the best consideration of your Hon. Court.

The system of a constant supply is now no longer a novelty. In Philadelphia, in New York, in Nottingham, in Preston, in Glasow, in Newcastle, in Bristol, and in various other places, this system has been adopted; its practicability and its advantages have been amply demonstrated.[1] Five years ago, when evidence on the subject was given before the House of Commons, it appeared that in the city and suburbs of Philadelphia 25,816 houses were supplied at an average rate of five dollars per house; that in Preston more than 5,000 houses were supplied continually at high-pressure, and that the company was increasing its tenants at the rate of 400 annually; that in Nottingham about 8,000 houses, containing a population of 35,000 persons, were supplied in the same manner; and in respect of many other towns, public experience has been equally extensive and satisfactory. About a month ago, the Sanitary Committee of the last-mentioned town published what I may call a report of congratulations on their freedom from cholera, which had visited the town with great severity in 1832. They detail the measures by which Nottingham has been rendered a healthy town, and the first time in that enumeration stands thus:—

"An unlimited supply of wholesome filtered water, forced, by day and night at high pressure, through all the streets to the tops of almost all the houses, at a cost, for the dwellings of the poor of about five farthings per week."

On the merits or demerits of the two competing systems of supply, I have only to speak so far as their adaptation to sanitary purposes is concerned. In this respect, I have no hesitation in saying that the system of constant supply is immeasurably superior to its rival; so superior, that unless competent engineering authorities should decide on its practical inapplicability to the City of London, I would strongly recommend its adoption as the only one, in my judgment, by which the growing necessities of the population can be fully and effectively satisfied.

Here again, as in an earlier part of my Report, I think it requisite to remark, that I do not mean in any degree to suggest that the evils adverted to present themselves within the City to a greater extent than in sundry other parts of the metropolis. My sphere of duty lies within the City boundary, and it would be an impertinence in me to comment, either favourably or unfavourably, on districts which lie within another jurisdiction than that of the Commission which I have the honour to address. Simply to guard myself against the possibility of being misunderstood, I again draw attention to the fact that I studiously refrain from instituting comparisons with other metropolitan localities. Let me likewise observe that I am far from insinuating, or suspecting, that the majority of the poorer population of the City has fallen to that extreme debasement which I have just illustrated as affecting some portion (perhaps not an inconsiderable portion) of the poorest; but I dare not suppress my knowledge that such instances exist, nor can I refrain from stating my belief, that ignorance and poverty will soon contribute to increase them, if sanitary and social improvement do not co-operate against their continuance.

Contemplating such cases, I feel the deepest conviction that no sanitary system can be adequate to the requirements of the time, or can cure those radical evils which infest the under-framework of society, unless the importance be distinctly recognized, and the duty manfully undertaken, of improving the social condition of the poor.

Those who suffer under the calamitous sanitary conditions which I have disclosed, have been led, perhaps, to consider them as inseparable from poverty; and after this long habituation to such influences, who can wonder if personal and moral degradation conform them more and more to the physical debasement of their abode? In the midst of inevitable domestic filth, who can wonder that personal cleanliness should be neglected? In an atmosphere which forbids the breath to be drawn freely, which maintains habitual ill health, which depresses all the natural spring and buoyancy of life, who can wonder that frequent recourse should be had to stimulants, which, however pernicious in themselves, still for a moment dispel the malarious languor of the place, give temporary vigour to the brain, and cheer the flagging pulses of a poisoned circulation? Who can wonder that habits of improvidence and recklessness should arise in a population, which not only has much ignorance and prejudice amongst it, but is likewise often unaccustomed to consideration and kindness? Who can wonder that the laws of society should at times be forgotten by those whom the eye of society habitually overlooks, and whom the heart of society often appears to discard?

I believe that now there is a very growing feeling abroad, that the poor of a Christian country can no longer, in their own ignorance and helplessness be suffered to encounter all the chances which accompany destitution, and which link it often indissolubly to recklessness, profligacy, and perdition. The task of interfering in behalf of these classes, however insensible they may be of their own danger and frequent degradation, begins at length to be recognized as an obligation of society; and as such an interference may be fraught with the utmost advantage of sanitary progress. . . .

City Medical Report No. 2, 1850
London Water

. . . The waters supplied to the City are conducted in open channels; they receive in large measure the surface-washing, the drainage, and even the sewage of the country through which they pass; they derive casual impurities from bathers and barges; they are liable to whatever pollutions mischievous or filthy persons may choose to inflict on them; and then on their arrival in the metropolis (after a short subsidence in reservoirs, which themselves are not unobjectionable) are distributed, without filtration, to the public.

Whatever chemistry may say on this subject . . . I cannot consider it a matter of indifference, that we drink—with whatever dilution, or with whatever imperfect oxidation—the excremental and other impurities which mingle in these sources of our supply. Such admixtures, though in their *quantity* less, are in their *quality* identical with those which render Thames-water, as taken at London Bridge, inadmissible for domestic consumption, and which occasion it, when stored for sea-use, to undergo, before it becomes fit to drink, a succession of offensive changes strictly comparable to putrefaction.

In this slovenly method of conveyance and distribution there is a neglect of common precaution for the purity and healthfulness of the supply, which I must report to you as highly objectionable; and this—the method of supply to our great metropolis, strikes one the more with astonishment and disgust, as one reflects on the long experience and admirable models which past centuries in foreign countries have supplied; and especially, as one remembers those colossal works which, more than two thousand years ago, were constructed under the Roman government, for the cool and cleanly conduction of water. . . .

Of other sources of water-supply existing within the City of London, there are many of small extent in the form of superficial springs. . . . To the use of water of this description, within a large city, there is always much objection. In addition to extreme hardness, which in London they universally possess, they are liable, in a dangerous degree, to become contaminated by the leakage of drains, and by other sources of impurity; as, for instance, where situated within the immediate vicinity of graveyards they derive products of animal decomposition from the soil. Very recently, a celebrated pump within the City of London, that adjoining St. Bride's church-yard, has been abandoned on account of such impregnations. Or perhaps I should rather say . . . that it was not abandoned—for till almost the last moment the neighbours adhered to it with fondness; but the parochial authorities—alarmed by the proximity of cholera—caused its handle to be locked. . . .

City Medical Report No. 2, 1850
London Smoke

. . . Those members of the Court [of Common Council] who have visited foreign capitals where other fuel than coal is employed, will remember the contrast between their climate and ours—will remember (for instance even in Paris) the transparence of air, the comparative brightness of all colour, the visibility of distant objects, the cleanliness of faces and building, instead of our opaque atmosphere, deadened colours, obscured distance, smutted faces, and black architecture. Those, even, who have never left our metropolis, but who, by early rising or late going to rest, have had opportunities of seeing a London sunrise, can judge, as well as by any foreign comparison, the difference between London as it might be and London as it is.

Viewed at dawn and noon-day, the appearances contrast as though they were of different cities and in different latitudes. Soon after daybreak, the great factory shafts beside the river begin to discharge immense volumes of smoke; their clouds soon become confluent; the sky is overcast with a dingy veil; the house-chimneys presently add their contributions; and by ten o'clock, as one approaches London from any hill in the suburbs, one may observe the total result of this gigantic nuisance hanging over the City like a pall.

If its consequences were confined to rendering London (in spite of its advantages) the unsightliest metropolis in Europe, to defacing all works of art, and rendering domestic cleanliness expensive, I should have nothing official to say on the subject; but inasmuch as it renders cleanliness more difficult, and creates a despair of cultivating it with success, people resign themselves to dirt, domestic and personal, which they could remove but so temporarily: or windows are kept shut, in spite of immeasurable fustiness, because the ventilation requisite to health would bring with it showers of soot, occasioning inconvenience and expense. Such is the tendency of many complaints that have reached me, and of their foundation in truth and reason I have thorough conviction and knowledge. . . . I ought likewise to tell you, that there are valid reasons for supposing that we do not with impunity inhale day by day so much air which leaves a palpable sediment; that many persons of irritable lungs find unquestionable inconvenience from these mechanical impurities of the atmosphere; and (gathering a hint from the pathology of vegetation) that few plants will flourish in the denser districts of London, unless the air which conduces to their nourishment be previously filtered from its dirt.

If the smoke of London were inseparably identified with its commercial greatness, one might willingly resign oneself to the inconvenience. But to every other reason against its continuance must be added as a last one, on the evidence of innumerable competent and disinterested witnesses, that the nuisance, where habitual, is, for the greater part or entirely, voluntary and preventable; that it indicates mismanagement and waste; that the adoption of measures for the universal consumption of smoke, while relieving the metropolis and its population from injury, would conduce to the immediate interest of the individual consumer, as well as to indirect and general economy. For all the smoke that hangs over us is wasted fuel. . . .

With the progress of knowledge on these subjects, a time will undoubtedly arrive, and at no distant period, when chimneys will cease to convey to the atmosphere their present immense freight of fuel that has not been burnt, and of heat that has not been utilized; when each entire house will be uniformly warmed with less expenditure of material than now suffices to its one kitchen fire; and our successors[2] will wonder at the ludicrous ingenuity with which we have so long managed to diffuse our caloric and waste our coal in the direct ions where they least conduce to the purposes of comfort and utility.

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CHAPTER 11

LEMUEL SHATTUCK
(1793–1859)

They [the Americans] have all a lively faith in the perfectibility of man; they judge that the diffusion of knowledge must necessarily be advantageous, and the consequences of ignorance fatal; they all consider society as a body in a state of improvement, humanity as a changing scene, in which nothing is, or ought to be, permanent.

—Alexis de Tocqueville, *Democracy in America*, 1835

Lemuel Shattuck occupies a stellar position in the history of public health as the American counterpart to Edwin Chadwick (who was a distant cousin). Born in Ashby, Massachusetts, on October 10, 1793, Shattuck grew up in a small farming village in New Hampshire. Little appears to have distinguished his childhood. A religious revival movement spread to his town, and at the age of 19 years, stimulated by that movement, he dedicated himself to improving society. One of his insights was the need for statistics to guide government in this regard.

Shattuck moved to Concord, Massachusetts, where he lived until 1833, earning his keep as a merchant. There he developed an interest in the town's history, which he published in 1835. Shattuck's *History of Concord* includes a statistical analysis of the municipality based on municipal and church records.

In 1833, Shattuck left Concord and settled in Boston, Massachusetts, where he functioned as both a bookseller and a politician. In the latter role, he served on the common council for Boston (first elected in 1837) and subsequently in the state legislature. The impact of his presence on the former can be gleaned by the publication of his *Vital Statistics of Boston*, written at the request of the Boston common council and covering the period 1810–1841. Parts of this report were published in the *American Journal of Medical Sciences*. In this volume, Shattuck described a system for the collection and analysis of vital statistics data. His arguments persuaded the Massachusetts legislature to pass the Registration Act of 1842. Shattuck then followed the success of his vital statistics book with his 1845 book *The Census of Boston*.

Shattuck was one of the five founding members of the American Statistical Association (founded as the American Statistical Society on November 27, 1839, in

Boston), serving as its first secretary. That organization credits him as its driving force in its early years. In 1844, Shattuck also founded the New England Historic-Genealogical Society. However, despite these manifold achievements, it is his *Report of the Sanitary Commission of Massachusetts 1850* for which Shattuck is best remembered today. Shattuck died in Boston, Massachusetts, on January 17, 1859.

A Note on the Text

The Massachusetts State Legislature commissioned the *Report of the Sanitary Commission of Massachusetts* while Shattuck served on that body. The document proscribed the development of state and local infrastructure for the collection and processing of information that would guide policymakers in improving the public's health. It is particularly noteworthy for the strong arguments it includes for passing legislation to establish a vital statistics system. Unfortunately, it was not acted upon when Shattuck delivered it, an experience quite different from that of his cousin Chadwick, though both are seen as the starting point for national public health movements.

The differences between the Chadwick and Shattuck reports are striking. The Chadwick report created a political firestorm. Chadwick emerged from it with considerable political power, the use of which resulted in his alienation of most of the major political figures whose support he needed to institute the numerous sanitary reforms his report called for. Although Chadwick's place in the history of public health is secure, his actual impact is more difficult to gauge. Shattuck, on the other hand, published a report that had little immediate impact. Nonetheless, the system Shattuck described for vital statistics collection and analysis was widely adopted and adapted across the United States. More than 150 years after its appearance, the Shattuck report continues to function as the blueprint for vital statistics systems. Chadwick's report, on the other hand, while of historical interest, does not serve a similar role today.

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Report of the Sanitary Commission of Massachusetts 1850
(1850, Abridged)

The Commissioners,[1] appointed on the third day of July last "to prepare and report, to the next General Court, a plan for a Sanitary Survey of the State, embracing a statement of such facts and suggestions as they may think proper to illustrate the subject," have considered the matters referred to them, as far as the limited time at their command, and other circumstances, since their appointment, would permit, and submit their Report.

As the object of our commission is comparatively new, and may not be clearly understood by every person, we will state what we understand to be its intention. By a Sanitary Survey of the State is meant, an examination or survey of the different parts of the Commonwealth,—its counties, its towns, and its localities,—to ascertain the causes which favorably or unfavorably affect the health of its inhabitants. The word *sanitary* means *relating to health*.[2] When we speak of the sanitary condition of a town, we include a description of those circumstances which relate to, or have an effect upon, the health of its inhabitants. When applied to the inhabitants of a town or district, in their social capacity, it relates to public health; when to individuals, it relates to personal or private health.

The condition of perfect *public health* requires such laws and regulations, as will secure to man associated in society, the same sanitary enjoyments that he would have as an isolated individual; and as will protect him from injury from any influences connected with his locality, his dwelling-house, his occupation, or those of his associates or neighbors, or from any other social causes. It is under the control of public authority, and public administration; and life and health may be saved or lost, and they are actually saved or lost, as this authority is wisely or unwisely exercised.

The condition of perfect *personal health* requires the perfect formation of all the organs of the body, and the perfect performance of each of their functions, in harmony with all the others. Such a condition gives to its possessor, strength, energy, power, buoyancy of spirit, happiness. *Disease* may be an imperfection in some organ, or a derangement or improper action in some function, or both: and it may exist, and does actually exist, in all communities, in an infinite number of degrees, from the slightest deviation from a standard of perfect health, through all the varieties of sickness, to the lowest standard of vitality, just as the body is about to perform its last respiration. Such a condition gives to its possessor, weakness, lassitude, inability, depression, pain, misery, death. And one or the other of these conditions may be chosen, and is actually chosen, to a greater or less extent, by almost every human being.

> *WE BELIEVE that the conditions of perfect health, either public or personal, are seldom or never attained, though attainable;—that the average length of human life may be very much extended, and its physical power greatly augmented;—that in every year, within this Commonwealth, thousands of lives are lost which might have been saved;—that tens of thousands of cases of sickness occur, which might have been prevented;—that a vast amount of unnecessarily impaired health, and physical debility exists among those not actually confined by sickness;—that these preventable evils require an enormous expenditure and loss of money, and impose upon the people unnumbered and immeasurable calamities, pecuniary, social, physical, mental, and moral, which might be avoided;—that means exist, within our reach, for their mitigation or removal;—and that measures for prevention will effect infinitely more, than remedies for the cure of disease.*

Some of the reasons for this belief will be given in the pages of this report. If it shall appear that it is well founded,—if, indeed, there are facts to support, and legitimate arguments to sustain it,—what subject, it may be asked, can come up for consideration, that shall transcend it in importance? We look upon things as valuable, that are worthless without life, and that cannot be enjoyed without health. How much more valuable, then, the means to possess and to enjoy both life and health, which alone give value to other objects! When compared together, all other matters this side the grave dwindle into insignificance.

But whom does this great matter of public health concern? By whom is this subject to be surveyed, analyzed, and practically applied? And who are to be benefited by this application? Some will answer, the physician, certainly. True, but only in a degree; not mainly. It will assist him to learn the causes of disease; but it will be infinitely more valuable to the whole people, to teach them how to prevent disease, and to live without being sick. This is a blessing which cannot be measured by money value. The people are principally concerned, and on them must depend, in part, at least, the introduction and progress of sanitary measures.

An eminent physician has recently said: "Our education has made our calling exclusively a curative, and not a conservative one, and the business of our responsible lives has confined us to it. Our thoughts are devoted to, our interests are concerned in, and our employments are connected solely with, sickness, debility, or injury,—with diminution of life in some of its forms. But with health, with fullness of unalloyed, unimpaired life, we, professionally, have nothing to do."[3] Though this may generally be true, professionally, yet the intelligent physician "can see arrows of disease, invisible to anyone else; watch their havoc, and know whence they come, and how they may be stayed;" and there are many eminent medical men, who have, as individuals, nobly used the means which their superior position and knowledge have placed within their control, in the prevention of disease, and in the promotion of public health. And we wish to increase the number of such professional men. We would not, however, confine it to them. We would not make it the object of any one profession exclusively.[4] We would bespeak the attention of intelligent men of all classes and all professions, whatever their prejudices or opinions may have been, to a candid consideration of the whole subject; and if found worthy, would solicit their cooperation and assistance, in its practical application and its onward progress.

"Ignorant men," says Dr. Simon, "may sneer at the pretensions of sanitary science; weak and timorous men may hesitate to commit themselves to its principles, so large in their application; selfish men may shrink from the labor of change, which its recognition must entail; and wicked men may turn indifferently from considering that which concerns the health and happiness of millions of their fellow-creatures; but in the great objects which it proposes to itself, in the immense amelioration which it proffers to the physical, social, and, indirectly, to the moral condition of an immense majority of our fellow creatures, it transcends the importance of all other sciences; and, in its beneficent operation, seems to embody the spirit, and to fulfill the intentions, of practical Christianity."[5]

In a subject of such vast importance, on which so little is generally known, and so much ought to be universally known, and which is so full of interesting and useful illustrations, it is difficult to confine ourselves within the limits of a single report of reasonable length. This great matter cannot, however, be presented so as to be understood, without some detail. And though we shall restrain any inclination to go into minute illustration, yet, in our judgment, it would be unworthy of Massachusetts, under whose authority we act, and it certainly would be unsatisfactory to ourselves, if we failed to make the attempt, at least, to present the subject so that the people of the State may know what we mean; so that they may be able, if they choose, to carry our recommendations into practical operation; and so that, if thus applied, they will add to their physical power, and increase their intellectual, social, and personal happiness.[6]

It should be borne in mind, however, that this report is designed to suggest a *plan* for a sanitary survey of the State, and not to contain the survey itself. We were authorized, however, by the resolve, to embrace a statement of such facts and suggestions as we might think proper to illustrate the subject. And as this is, in some respects, a report introductory to other useful in formation, which may hereafter be diffused, if our recommendations should be adopted, it has seemed to us that it would be instructive and proper here, to make a general survey of what has been suggested, and what has already been done on the subject, abroad and at home. Without such a view, we cannot wisely form a plan for our own guidance. We have accordingly been at no inconsiderable labor and expense, to obtain the most recent authentic information concerning the history and present condition of the sanitary movement; and we shall proceed to give some of the results of the investigation, before presenting our plan for a sanitary survey of this State.

I. The Sanitary Movement Abroad

[This section deleted to save space. Ed.]

II. The Sanitary Movement at Home

Sanitary Police. Some historical notice of the sanitary legislation of Massachusetts, seems proper, preliminary to any statements of its present condition. We have accordingly presented, in the appendix, the titles of all the acts relating to matters connected with the public health, from the commencement of the provincial charter, in the year 1692, to the present time, arranged in chronological order; and referred, in connection, to the printed works where they may be found. The subject seems to have received little attention from the General Court, during the old colonial charter.[7] Two acts, which have some relation to it, we shall presently notice. Laws were passed by the provincial government, relating to nuisances, drainage, smallpox, and some other matters; many of which were special acts, or partial in their operation. But though imperfect, they ate honorable to the State, and exhibit the care which the legislature has ever wished to exercise over the people. To them we have been indebted for many excellent sanitary municipal regulations, which have continued until the present time.

Nuisances. In 1692 and 1708, acts were passed, providing that "in Boston, Salem, Charlestown, respectively, and other market towns in the province," "slaughter-houses for killing of meat, still-houses, and houses for the trying of tallow, currying and dressing of leather, either with time, alum, or oil, be assigned by the selectmen to places where it may be least offensive," and prohibited elsewhere; and records were to be kept of such assignment. [The remainder of this section has been deleted to save space. Ed.]

Drainage and Sewerage. In 1702, an act was passed providing "for appointing commissioners of sewers, for the draining and removing of the banks and obstructions of the passage of waters in rivers, brooks, or ponds that occasion the overflow and drowning of meadows and low lands; and also for the draining and flowing of swamps and other unprofitable grounds, and drying of them." Another act, "for regulating drains and common shores," [sewers,] was passed in 1709, placing them under the direction and control of the selectmen of the town. [The remainder of this section has been deleted to save space. Ed.]

Sickness. Legislation on this subject, principally with reference to the small-pox, has been frequent in the history of the State. As early as 1701, "an act providing in case of sickness," was passed, "for the better preventing the spreading of infection." By this act, when persons "were visited with the plague, small-pox, pestilential[8] or malignant fever,[9] and other contagious sickness, the infection whereof may be communicated to others," the selectmen were empowered, "for the preservation of the inhabitants," to remove such infected persons to separate houses, and to provide "nurses, tendance, and other assistance and necessaries for them, at the charge of the parties themselves, their parents or masters, (if able) or otherwise at the charge of the town or place whereto they belong." And the sheriff of the county, his deputy, or the constable of the town, were required, under direction of the selectmen, "to impress and take up convenient housing, lodging, nurses, tendance,[10] and other necessaries for the accommodation and relief of the sick." And if a vessel arriving in the province happened "to be visited with the plague, small-pox, pestilential or malignant fever, during the voyage, or to come from any place where such sickness prevailed," they were authorized to prevent all persons belonging to the ship coming on shore, or those on shore having any intercourse with them. This has been the foundation of all the sanitary laws passed since that time. [The remainder of this section has been deleted to save space. Ed.]

Insanity. In 1694, towns were required to provide for the "relief, support, and safety" of persons "naturally wanting of understanding, so as to be incapable to provide for him or herself, or by the providence of God shall fall into distraction, and become non compos mentis." Acts "for suppressing rogues, vagabonds, common beggars, and other idle and disorderly and lewd persons," were passed in 1758 and 1798, by which justices were empowered to commit insane persons to the house of correction. These acts were repealed in 1834, though some of their bad features are still retained. It seems to us that, unless crime has actually been committed, insane persons should not be treated as criminals, but should be restrained and provided for by some other tribunal than a criminal court.

Quarantine. We have already alluded to one law, partially quarantine. In 1700, the master of ships were required to furnish a list of all passengers to the selectmen of towns, and give security for the support of any "impotent, lame, or infirm person" who might be discharged. At a subsequent period, not exactly known, a hospital was erected on Spectacle Island, by the town of Boston; and, in 1736, an arrangement was made between Boston and the Commonwealth, for a permanent quarantine establishment on Rainsford's Island. [The remainder of this section has been deleted to save space. Ed.]

Special Legislation. The first Board of Health in the State was established in Boston, by a special act of the Legislature, passed February 13, 1799.

[The pages discussing the passage of health legislation have been deleted here to save space, including a table of dates establishing various Boards of Health in Massachusetts. Also deleted are the discussions of establishing vital registration, professional medical organizations, medical schools, and medical journals in the state. Ed.]

. . . The sanitary history and condition of the State should be known; for this knowledge might suggest the remedial measures proper to be adopted; and we deem it proper, in this connection, to refer briefly to some of the facts which we have gleaned on the subject.

In 1618, two years before our forefathers arrived at Plymouth, there appeared, among the Indians of the country, one of the most remarkable epidemics of which we have an account. So was the pestilence, that the warriors "were reduced from nine thousand to a few hundreds." The Massachusetts tribe supposed to have lost 2,700 out of 3,000 persons. In 1621, many places which had been populous Indian villages "all deserted—all dead." The bones of those who perished were lying unburied. Hutchinson says some have supposed the disease to have been the small-pox; but from the Indian account we might infer otherwise. Gookin says, "What the disease was which so generally and mortally swept them away, I cannot learn. I have discoursed with some old Indians then youths, who say that the bodies all over were yellow, (describing it by a yellow garment they showed me) both before they died, and afterwards." It has been inferred from this that it was the yellow fever; but whether correctly or not seems undetermined.[11]

1621. At the commencement of the settlement of Plymouth, our venerable ancestors suffered severely from sickness. At the end of three months after their arrival, fifty-five only survived of the one hundred and one who came in the Mayflower. "The sick were destitute of almost all the comforts which their miserable condition rendered indispensable. Their sufferings were increased by the want of well persons to perform the duties among the sick; there being, at one time, not more than six or seven persons in tolerable health."[12]

1631. The small-pox, first breaking out at Saugus, spread from Narraganset to Piscataqua, and westward to Connecticut River, and swept off entire villages of the Indians. When Increase Mather wrote, there were living some old residents, who on that occasion helped to bury whole families of the natives at the same time.

1633. At the close of this year the small-pox again broke out, and made great devastations among the unfortunate native races of Massachusetts. Chickatabut, the great sachem of the tribe, was among the victims.

1634. Plymouth was again visited with a mortal sickness, of which twenty men, women and children died; among whom was that most excellent and pious man, Dr. Samuel Fuller, the first physician of New England. "It must have been occasioned by a fever of domestic origin, as the colony had at that time so intercourse with foreign countries, except England."

1639. Was sickly in the colonies, and a general fast was observed on account of the small-pox and fevers.[13]

1645. Great sickness prevailed among the Indians at Martha's Vineyard. Few escaped.

1647. A malignant fever prevailed, "occasioned by the excessive heat of summer;" and an epidemic influenza passed through the whole country, and universally affected the colonists and natives; but it was not very mortal: "where in a special providence of God appeared, for not a family nor but a few persons escaping it; our hay and corn had to be lost for want of help; but such was the mercy of God to his people, as few died—not above forty or fifty in the Massachusetts, and near as many at Connecticut."[14]

1654. A general fast was appointed, on account of "the mortality which had been among the people of Massachusetts." What the disease was does not appear.

1655. Another epidemic distemper, similar to that of 1647, passed through New England. It began in June, and few persons escaped. Among those who died was Rev. Nathaniel Rogers, of Ipswich.

1658. Sickness and mortality throughout New England.

1659. Croup is first mentioned in the annals of the country. Other malignant diseases also prevailed about this time. Thirty children died in Rowley. A day of thanksgiving was appointed in Connecticut, for the "abatement of the sickness in the country, and a supply of rain in time of drought."

1668. Was a year of great sickness, though few facts are preserved concerning its extent. In New York a public fast was held on account of it.

1677. Small-pox was very fatal in Charlestown. The records state that thirty-one died of the disease, one of whom was the Rev. Thomas Shepard.

1678. Small-pox in Boston; but we have seen no account of its victims.[15] Seven or eight hundred are said to have died of it in the State. About this time "the seasons were unfavorable, and the fruits blasted, while malignant diseases prevailed among the people. The sickness and bad seasons were attributed by our pious ancestors to the irreligion of the times, and to their disuse of fasting; and a meeting was held to investigate the causes of God's judgments, and to propose a plan of reformation."[16]

1697–98. The influenza began in November, and prevailed until February, in Massachusetts. Whole families and whole towns were seized nearly at the same time. In the same year, a "mortal disease" prevailed so much, in Fairfield, Connecticut, that well persons were not found to take care of the sick and bury the dead. Seventy died in three months, out of a population of less than one thousand. At the same time, a dreadful mortality occurred in Dover, New Hampshire. Rev. Dr. Mather said, in a sermon preached in Boston, in 1698: "The smallpox has four times been a great plague among us. Often had one hundred bills, desiring prayers for the sick, been read in one day, in one of our assemblies. In one twelve month about one thousand of our neighbors have been carried to their long home."

1702. Small-pox in Boston; two hundred and thirteen, exclusive of blacks, died; about. 4.4 per cent. of the inhabitants. It began in June, 1702, but the first death was in August of that year. In September, it became very mortal, and was attended with a fever resembling the scarlet fever. In October many died. The General Court sat at Cambridge, and they passed the first law for protection against the small-pox already noticed. It began to subside in February, 1703.[17]

1715. Plymouth lost forty of its inhabitants by a malignant disease, but no particulars are known.[18]

1717–1718. From November to February, "a very malignant and mortal distemper" prevailed in Concord. Twenty-seven persons, chiefly heads of families, died; many very suddenly. The disease is not named in the record.[19] A fast was held in Danvers, February 13, on account of a fatal disease that prevailed at the village, which threatened at one time to sweep away the entire population.[20]

1721. The small-pox again made its appearance in Boston, with more than its usual ravages and horrors, and was the occasion of one of the most remarkable and important events in the sanitary history of the State. *Inoculation with the virus of small-pox*, as a substitute for the disease taken in way,—to disarm it of its malignity, and to reduce it to comparative mildness and safety,—was first introduced this year. Rev. Dr. Cotton Mather, having read, in the Transactions of the Royal Society of London, favorable accounts of the operation, recommended a trial of it to the physicians of Boston; but all of them unanimously and decidedly opposed it, excepting Dr. Zabdiel Boylston. That enlightened and upright man became forcibly impressed with the importance of the discovery; and, to show his confidence in it, made the first experiment on his own son, thirteen years of age, and persons in his family, one two, and the other thirty-six old; and all with complete success. Subsequently, others were inoculated.

The controversies which accompanied the introduction of this useful measure, were most disreputable. Many persons were struck with horror; some thought it was sinning against God, thus to interfere with the disease; and others that, if any patients died, Dr. Boylston ought to be treated as a murderer. Pamphlets and newspaper articles frequently appeared; and the populace, chiefly led on by the inflammatory conduct of the physicians, at the head of whom was Dr. Douglass, became so exceedingly enraged, that Dr. Boylston was frequently insulted in the streets, and forced to secrete [*sic*] himself for more than fourteen days, and afterwards to visit his patients only at midnight. His family were hardly safe in his own house. Passion and prejudice on the one side, however, were met with decision and on the other; and inoculation soon triumphed over opposition, and became general.[21]

During this epidemic, 5,759 persons,—more than half the inhabitants,—had the disease in the natural way, of whom 844 died. Two hundred and forty-seven were inoculated by Dr. Boylston and thirty-nine by other physicians, of whom six only died. This was one death in seven of those not inoculated and one in forty-seven of those inoculated, showing decidedly the advantages of inoculation.

1735. On the 20th of May, in this year, scarlatina, or putrid appeared in Kingston, New Hampshire, and became one of the most dreadful epidemics which have ever desolated New England. [The remainder of this section has been deleted to save space. Ed.]

From 1745 to 1749, several sickly seasons occurred; but we have seen no definite account of them, which would exhibit their extent.

1752. Small-pox ill Boston: 7,669 cases occurred,—5,545 in the natural way, and 2,124 by inoculation,—in a population of 15,684, of whom 569 died.

1755. An alarming fever appeared in Pepperell, and spread to some of the neighboring towns, during this and the three subsequent years. From its origin and great mortality, it acquired the popular name of the *Pepperell Fever*. Physicians called it a "*putrid malignant nervous fever*;" probably the same as a severe form of the typhus. [The remainder of this section has been deleted to save space. Ed.]

1763. "In August, the Indians on Nantucket were attacked by a bilious[22] plague; and, between that time and the February following, their number was reduced from 358 to 136. Of 258 who were affected, 36 only recovered." The Indians on Martha's Vineyard suffered from the same fever. Not a family escaped. Of 52 attacked, 39 died. It was confined in both places to the Indians, and none but those of full-blood died![23]

1764–1780. During this period there were many years of sickness, but we have few facts preserved to show its extent. [The remainder of this section has been deleted to save space. Ed.]

In 1780 a malignant typhus appeared in Boston, having been introduced by the Alliance frigate. Many were sick, and several died.

1792. This was the memorable small-pox year in Massachusetts. "The consequences which ensued constituted a scene of confusion and wretchedness which no one, who was a witness of it, could have viewed with but horror and commiseration. It is to be hoped, for the cause of humanity, that the inhabitants of Boston will never again experience this calamity; as they have it now in their power, by embracing the means which heaven has put into their hands in the vaccine inoculation, to secure themselves forever from its desolating ravages."[24] [The remainder of this section has been deleted to save space. Ed.]

1796. This was a very sickly year. In Boston, a very malignant typhus appeared on the 25th of August; and between that time and December many were sick, and thirty died. It created great alarm and some were buried in the night.[25] [The remainder of this section has been deleted to save space. Ed.]

1798. The yellow fever appeared in Boston, June 17. [The remainder of this section has been deleted to save space. Ed.]

1800. The question whether overflowing lands for mill ponds or other purposes, generated a malaria which was unfavorable to health, was much discussed about this time, especially by the people in the westerly part of Massachusetts, and in Connecticut. [The remainder of this section has been deleted to save space. Ed.]

1802. The yellow fever again appeared in Boston. [The remainder of this section has been deleted to save space. Ed.]

1804–05. A typhus of "uncommon malignity" appeared in Boston: fifteen died of the disease.

1805–1810. The spotted fever and other epidemics prevailed during this period in some parts of the State, though no very particular account has been published concerning them. [The remainder of this section has been deleted to save space. Ed.]

1812–1814. This period witnessed the introduction of a most fatal and alarming epidemic. [The remainder of this section on typhus and "pulmonic fever" has been deleted to save space. Ed.]

1815–1816. This winter, a typhus fever of malignity, similar to that of 1812–1814, already noticed, and confining its attacks principally to old people, appeared. [The remainder of this section has been deleted to save space. Ed.]

1819. The yellow fever, again appeared in Boston, and created great alarm. [The remainder of this section has been deleted to save space. Ed.]

1831–1832. In Boston, 70 died of Asiatic cholera in 1832. Of scarlatina, 84 died in 1831, and 199 in 1832. Typhus was also charged with 45 deaths. The cholera excited great alarm, and caused special preparations to be made in the city for its avoidance.[26] [The remainder of this section has been deleted to save space. Ed.]

For the last forty years, notwithstanding the mass of medical literature that has been published, less definite information has been obtained concerning epidemics than in the previous periods. The almost entire neglect of records, prior to the adoption of the registration system, renders it difficult to give any thing approximating to an accurate view of the subject. [The remainder of this section has been deleted to save space. Ed.]

To complete this general view of the sanitary condition of the State, and as further illustrations, we have compiled from the Registration Reports, from the "Bills of Mortality" of Boston, and from other sources of information, several tabular statements, which we shall now present. . . .

The *influence of the seasons* upon health has universally been regarded as important. Some diseases prevail with more frequency and malignity at one season than at another. Persons at the extreme ages of life,—the young and the old,—and those of feeble health, are, however, most liable to be affected by the changes of the seasons. . . .

The *influence of occupation* on health and longevity is worthy of consideration. . . .

The Registration Reports contain an abstract of the number and ages of all over 20 years, whose occupations are specified in the returns. We select and combine the facts in all the reports, relating to the following occupations, as further illustrations:—

[A discussion of the deaths of clergymen, physicians, and lawyers has been deleted to save space. Ed.]

The *influence of domestic condition* on the sanitary welfare of the people is supposed to be great. . . . [Tabular data comparing Massachusetts to England and Belgium have been deleted to save space. Ed.] [I]t appears that the average age at which men marry, for the first time, in Massachusetts, is 25.71 years; and women, 22.61 years. In England, the first marriage of men is at 25.45 years, and of women at 24.30; and in Belgium of men at 29.47, and of women at 27.43. This shows that there is a difference in the ages at which females marry, between Massachusetts and England, of nearly two years; and between Massachusetts and Belgium, of five years. The average age of all marrying in Massachusetts, (either first or subsequent marriages) is, of men, 28.27 years, and of women, 24.50; and in England, of men, 27.30, and of women, 25.35. . . . [A discussion of widowhood has been deleted to save space. Ed.]

The *influence of disease* is the most important test of the sanitary condition of the State. . . . The diseases are classified according to the plan recommended by the Registrar General of England. . . .

[A table containing causes and numbers of death has been deleted to save space and the lengthy discussion summarized below. Ed.]

Statement of the Rate of Mortality among the inhabitants of Boston, for 1830, 1840 and 1845; and of an interior country town in Massachusetts, for 1830						
Ages	**Population of Boston**					**Population of Country Towns**
	1830	**1840**		**1845**		
	Both Sexes	**Both Sexes**	**Males**	**Females**	**Both Sexes**	**Both Sexes**
Under 5	8,068	11,522	7,234	7,214	14,448	1,249
5 to 10	6,016	8,956	5,690	5,668	11,358	1,036
10 to 15	5,501	7,221	4,708	4,928	9,636	963
15 to 20	6,903	8,841	5,199	5,750	10,949	1,013
20 to 30	16,182	22,960	15,009	14,586	29,595	1,791
30 to 40	9,070	112,675	10,455	9,526	19,981	1,129
40 to 50	5,019	6,707	4,991	5,038	10,029	752
50 to 60	2,569	3,561	2,142	2,618	4,760	488
60 to 70	1,316	1,640	1,062	1,406	2,468	356
70 to 80	504	673	315	578	893	241
80 to 90	140	212	73	146	221	86
Over 90	14	32	12	16	28	9
All ages	61,392	85,000	56,890	57,476	114,366	9,113
Deaths in Boston for 9 years						**Deaths for 10 yrs**
Under 5	4,334	7,660	6,224	5,481	11,705	38.2
5 to 10	448	738	703	609	1,912	6.2
10 to 15	274	397	292	341	633	3.1
15 to 20	309	483	330	408	738	5.3
20 to 30	1,526	2,036	1,556	1,747	3,303	13.2
30 to 40	1,484	1,766	1,540	1,377	2,917	11.1
40 to 50	1,025	1,276	1,138	810	1,948	11.0
50 to 60	678	903	679	594	1,273	9.4
60 to 70	544	723	516	541	1,057	11.0
70 to 80	420	589	324	463	787	13.8
80 to 90	205	293	137	242	379	11.6
Over 90	41	54	28	47	75	2.1
All ages	11,288	16,858	13,467	13,660	26,137	136.0

Annual Mortality Percent						
Under 5	5.96	7.32	9.55	8.44	9.00	3.05
5 to 10	.81	.91	1.37	1.19	1.28	.59
10 to 15	.55	.61	.68	.76	.72	.32
15 to 20	.49	.60	.70	.78	.74	.52
20 to 30	1.04	.98	1.15	1.33	1.24	.73
30 to 40	2.01	1.54	1.63	1.60	1.62	.98
40 to 50	2.24	2.11	2.53	1.78	2.15	1.46
50 to 60	2.93	2.81	3.52	2.52	2.97	1.92
60 to 70	4.58	4.89	5.39	4.27	4.75	3.08
70 to 80	9.24	9.71	11.42	8.89	9.78	5.72
80 to 90	16.21	15.33	20.82	18.10	19.04	13.48
Over 90	32.14	18.5	25.83	32.50	29.64	23.33
All ages	2.04	2.20	2.63	2.44	2.53	1.49
Living to 1 death	48	45	38	41	39	67

1. The *Zymotic*,[27] or epidemic, endemic, and contagious diseases, or causes of death. The extent to which these diseases prevail is the great index of public health. When the proportion is comparatively small, the condition of public health is favorable; when large, it is unfavorable. If, as a class, these diseases are found to decrease, it must be inferred that the general health of the people is improving; if otherwise, that it is growing worse. . . .

2. In the *Diseases of Uncertain Seat*, the greatest number appear against infantile . . .

3. The *Diseases of the Nervous Organs* have prevailed in about the same proportion at the different periods. The annual number of deaths by *Hydrocephalus*, which principally affects children surrounded by bad sanitary influences, has nearly doubled in Boston within the last thirty years.

4. The *Diseases of the Respiratory Organs* furnish one of the largest classes of causes of death; and, in this class, consumption and pneumonia (inflammation of the lungs, or lung fever) are preeminent. . . .

5. The *Diseases of the Circulative Organs* are principally confined to those affecting the heart. These seem to have increased, both in the State and in Boston.

	Occupations	Agg. Age	Avg. Age		Occupations	Agg. Age	Avg. Age
4737	Farmers	313,606	64.89	46	Bakers	1,961	46.69
39	Hatters	2,293	58.79	81	Cabinet-makers	3,629	44.80
110	Coopers	6,313	57.39	73	Stone-cutters	3,246	44.46
114	Clergymen	6,457	56.64	17	Paper-makers	753	44.29
55	Lawyers	2,940	55.47	902	Shoe-makers	39,169	43.41
137	Physicians	7,535	55.00	1609	Laborers	68,858	42.79
287	Blacksmiths	15,639	54.4	1061	Seamen	45,070	42.47
613	Carpenters	31,366	51.16	110	Painters	4,657	42.36
323	Merchants	16,386	50.73	138	Fishermen	5,745	41.63
65	Tanners/Curries	3,244	49.90	115	Manufacturers	4,656	40.48
135	Masons	6,541	48.45	110	Mechanics	4,095	37.20
213	Traders	9,967	46.79	34	Printers	1,255	36.91

6. The *Diseases of the Digestive Organs* embrace a very large class. Some may be zymotic or sporadic, as circumstances occur by which they are developed. . . .

7. The *Diseases of the Urinary Organs* do not constitute a large class, and in neither period amount to one per cent. Gravel and diabetes are the most numerous of the class.

8. The *Diseases of the Generative Organs* are all important though not a large class. Cases of puerperal fever are classed under the diseases of childbirth. . . .

9. The *Diseases of the Locomotive Organs*. Rheumatism, or rheumatic fever, has occasioned the greatest number of deaths. Spinal diseases are also increasing.

10. The *Diseases of the Integumentive Organs* have caused about the same uniform proportion. *Ulcers* are stated to have produced more deaths than all other diseases of this class.

11. *Old Age* has fewer deaths, in proportion to the whole, to record among its victims now, than at the former periods of our history. . . .

12. The *Deaths by Violence* are nearly as great in the country as in Boston, though the proportional numbers vary in both places. Accidents and drowning are the most numerous causes. Burns and scalds, intemperance and suicide, cause nearly the same proportions.

The following are some of the many important conclusions to which the facts thus far disclosed lead us:—

1. *It is proved* that there is a great difference, in this State, in the longevity of people living in different places and under different circumstances. . . .

2. *It is proved* that causes exist in Massachusetts, as in England, to produce premature and preventable deaths, and hence unnecessary and preventable sickness; and that these causes are active in all the agricultural towns, but press most heavily upon cities and populous villages.

3. *It is proved* that measures,—legislative, social and personal,—do not at present exist, or are not so fully applied, as they might be, by the people, for the prevention, mitigation, or removal, of the causes of disease and death.

4. *It is proved* that the people of this State are constantly liable to typhus, cholera, dysentery, scarlatina, small-pox, and the other great epidemics; and to consumption, and the other fatal diseases, which destroy so many of the human race in other parts of the world.

5. *It is proved* that the active causes of disease and death are increasing among us, and that the average duration of life is not as great now as it was forty or fifty years ago.

We are fully aware that the general opinion does not coincide with this fact, and that a directly opposite one has been expressed. It has been frequently said, that, owing to the different modes of living, the increased medical skill, and other causes, diseases have been ameliorated, and the average length of human life has been extended; and particularly within the last fifty years. We have long thought differently, especially in regard to the more recent periods of our history. Those who make this assertion seem to rely upon imperfect or uncertain data to support their opinion. Statistical observations of the living and the dead, gathered in ancient times, should be taken with great caution as comparative tests. Ten years since, it was said that "the average value of life is not as great as it was twenty years ago; that it was at its maximum in 1810 to 1820; and that it has since decreased."[28] Subsequent investigations have fully established the correctness of this statement. . . .

It is undoubtedly true, that in many things society has improved; that medical skill in the cure of disease has greatly increased; and that some diseases are not as fatal as formerly, or are now better understood and controlled. But while all this may be true, it is no less true that the active causes of disease have increased faster than the appliances for their prevention and cure; that new diseases, or old ones in a new and modified form, equally fatal and uncontrollable, have appeared; and that sickness and death advance more rapidly than the improvements devised to arrest them.

[Discussion of comparative mortality in England and Geneva, Switzerland, have been removed here to save space. Ed.]

III. Plan for a Sanitary Survey of the State

We now proceed to give an outline of a plan for the Sanitary Survey of the State which we propose for adoption. . . .

Health is a variable matter, capable of improvement or deterioration. It may be good in one year, and not in another, and not alike in two places at the same time. No plan can therefore be extensively useful, or permanently valuable, which shall be confined to a single year or a single survey. It should extend over a series of years, and through a series of successive observations and examinations. In this way only can the laws of health and life of any place be accurately ascertained, and a sanitary survey produce all the good that might be attained by it. People are prone to neglect their own and the public health, and this fact is a reason why the subject should be frequently brought to their notice.

Our plan consists of a series of measures, which may be rendered permanent if desired; presented in the form of separate recommendations. They are divided into two classes, and are to be regulated and controlled by the agencies which are proposed to be established; one by the legislative authority of the State, and the municipal authorities of towns and cities, and the other by social organization and personal action. Though intimately connected, these measures are in some respects independent of each other. They are not of equal importance, and it is not expected—they will all be immediately made use of; a part only may be adopted at one time, and another part at another time, as circumstances may require. They are here presented together, as necessary to—give fullness and unity of design to the whole plan. It is not supposed, however, that they are all the useful sanitary measures which a complete and perfect plan would require. The progress of this inquiry, and the circumstances which it develops in different years,—the discoveries which will be made by the united intellectual efforts that will be brought to bear upon this subject, will suggest others. Some of these measures are of great magnitude, and would each furnish matter for a volume, if, fully explained and illustrated. All we propose to do in this connection is, to name and define each, and to give a brief explanation and illustration of its character and design. These measures, it must be recollected, however, are only a series of plans by which a sanitary survey might be carried forward. The accompanying information is inserted merely to illustrate these plans.

I. State and Municipal Measures Recommended

Under this class of recommendations are to be included such measures as require, for their sanction, regulation and control, the legislative authority of the State, or the municipal authority of cities and towns. They may be called the legal measures,—the *Sanitary Police* of the State. . . .

I. *We recommend that the laws of the State relating to Public Health be thoroughly revised, and that a new and improved act be passed in their stead.*

. . . [W]e suggest that a general health law should be passed, which should be comprehensive in its design and simple in its provisions,—be adapted to the present circumstances of the State, and be so framed that it might be clearly understood and carried into practical operation; and which while it would answer all the purposes of a general health act as heretofore understood, would, at the same time, accomplish all the purposes of a sanitary survey.

II. *We recommend that a* GENERAL BOARD OF HEALTH *be established, which shall be charged with the general execution of the laws of the State, relating to the enumeration, the vital statistics, and the public health of the inhabitants.*

The duties of the Board. . . . They are to have the general direction of each census; to superintend the execution of the sanitary laws of the State; to examine and decide upon sanitary questions, submitted to them by public authorities; to advise the State as to the sanitary arrangements of public buildings and public institutions; to give instructions to local Boards of Health, as to their powers and duties; to suggest local sanitary rules and regulations; to recommend such measures as they may deem expedient, for the prevention of diseases and the promotion of the public health; and to report their proceedings annually to the State.

III. *We recommend that the Board, as far as practicable, be composed of two physicians, one counselor at law, one chemist or natural philosopher, one civil engineer, and two persons of other professions or occupations; all properly qualified for the office by their talents, their education, their experience, and their wisdom.*

. . . The members should not be selected exclusively from one profession, for two reasons:—(1) Numerous questions, requiring a knowledge possessed by different professions, will be presented for discussion and decision; and it is desirable that the Board should be able to bring competent knowledge to the investigation of every subject. And (2) To show to all that the promotion of public health is a matter which does not belong exclusively to the medical profession, but concerns every profession and every person. The idea which too generally prevails, that every thing relating to health belongs exclusively to one profession, operates against sanitary improvement. The services of medical men are indispensable; but the services of other professions, and of every person in their respective spheres must be put in requisition, before reform can be complete. . . .

IV. *We recommend that the Board be authorized to appoint some suitable and competent person to be the Secretary of the Board, who should be required to devote* *his whole time, and energies to the discharge of the duties of his office, and be paid a proper salary for his services.*

. . . He should be amply qualified, in all respects, for the office; know what to do, and how to do it, and what information to obtain, and how to obtain it. He should be thoroughly educated in the science of public health, and the causes and prevention of disease; and be capable of arranging, analyzing, abstracting, combining, and publishing the facts that may be collected, with proper deductions and conclusions from them, in such form as will be most useful to science, and contribute most to the improvement of practical life. To discharge the duties of such an office in such a manner as they might and ought to be discharged, would, in our judgment, be enough to satisfy the desires of any man who wished to be honored and useful.

V. *We recommend that a* LOCAL BOARD OF HEALTH *be appointed in every city and town, who shall be charged with the particular execution of the laws of the State, and the municipal ordinances and regulations, relating to public health, within their respective jurisdictions.*

. . . The duties of these Boards are . . . to carry into execution, within their own town, the sanitary laws of the State, and the orders of the General Health; and, as far as possible, to prevent disease, and raise the standard of public health to the highest point. . . . [Discussions concerning the structure of and expenses incurred by the Boston Board of Health and the existence of other Boards of Health in Massachusetts have been deleted to save space. Ed.]

VI. *We recommend that each local Board of Health appoint a Secretary; and also, if occasion require, a Surveyor and Health Officer.*

. . . Every Board should have a secretary, to keep its records, books and papers, and perform such duties as usually pertain to such an office. A surveyor or engineer would also be useful, especially in cities and populous villages. . . . Each Board should have an Officer of Health, who should, where practicable, be an intelligent physician, well educated, and especially acquainted with sanitary science, having no peculiar theory to build up or support, as regards different modes of practice for the cure of disease, but conscientiously desirous of doing all within his power to prevent disease, and to raise the standard of health within his jurisdiction, by carrying into execution all proper local regulations, and those of the general Board of Health. Some towns may not be able to select such as one, and in such cases, persons of other professions or occupations may be substituted. . . .

VII. *We recommend that local Boards of Health endeavor to ascertain, with as much exactness as possible, the circumstance of the cities and towns, and of the inhabitants under their jurisdictions; and that they issue such local sanitary orders and make such regulations as are best adapted to these circumstances.*

. . . No regulations inconsistent with the constitution and laws of the State, however, can in any case be made. Any regulation may be modified or annulled, as circumstances may require. Discretion and wisdom, in this as in other matters, will be required in carrying this provision into effect. . . .

VIII. *We recommend that local Boards of Health endeavor to carry into effect all their orders and regulations in a conciliatory manner; and that they resort to compulsory process only when the public good requires it.*

. . . Boards of Health should diffuse information concerning their regulations, and the measures they propose for execution; and public opinion should be educated and properly influenced in their favor. It would be unwise, in most cases, to enforce any regulation or measure against the general and deliberate wishes of the inhabitants, after such a regulation has been fully and fairly laid before them and comprehended. . . . Cases may occur, however, where, in a house or a locality, a nuisance or a disease may exist, which is directly injurious to the health of the neighborhood, and which the owner or occupant, even after persuasion and remonstrance, refuses to remove or abate. In such cases it becomes the *duty* of the Board of Health to interfere. Public safety requires it—human life demands it. . . .

IX. *We recommend that an appropriation be made annually by the State, for the purchase of books for the use of the general Board of Health; and by each city and town for the purchase of books for the use of each local Board of Health.*

[Section discussion deleted to save space. Ed.]

X. *We recommend that each local Board of Health be required to make a written report annually to the town, concerning its sanitary condition during the next preceding year; and to transmit a written or printed copy of the same to the General Board of Health.*

. . . A copy of the reports from every town in the State is to be transmitted to the General Board of Health to furnish materials for their annual reports. In this way a sanitary survey of the State would be made and published every year, imparting information of the utmost importance.

XI. *We recommend that the sanitary and other reports and statements of the affairs of cities and towns which may be printed should be in octavo form, on paper and page of uniform size,(similar to the public documents of the State) and designed to be bound together, as* THE ANNUAL REPORTS OF THE TOWN*; and that five copies be preserved by the Board of Health, one copy be furnished to the General Board of Health, one to the state Library, and that others be given to Boards of Health elsewhere in exchange for their publications.*

[Section discussion deleted to save space. Ed.]

XII. *We recommend that the successive enumerations of the inhabitants of the State be so made, abstracted, and published, that the most useful and desirable information concerning the population may be ascertained.*

. . . To fulfill all the political requirements of the constitution of the United States, and of this State, an enumeration of the whole number of the inhabitants, merely, without any particulars except a statement of the free and slave population separately, and "excluding Indians not taxed," is all that is required. . . . In our judgment, the following classes of facts are desirable in every census:[29]

1. *Color and Freedom.* Three classes of persons exist in this country,—the whites, the colored, and the Indians; and of the colored there are two subclasses—the free and the slave. The political rights, possessed by each of these classes, differ in different states; and it has been supposed that they are not all affected alike by the same sanitary influences. The numbers possessing each of these characteristics should therefore be ascertained both for political and sanitary purposes.
2. *Sex* is another characteristic universally acknowledge as important, and the numbers of each should be carefully obtained.
3. The *Ages* of the population are characteristics, interesting and important in many respects, and indispensably necessary in all sanitary inquiries. Without them a census is comparatively useless. . . .
4. The *Domestic Condition*, or the number of unmarried, married, and widowed, is an interesting characteristic, which has been ascertained in the censuses made by nearly all the governments of Europe, and should be known for its important social and sanitary influence.
5. The *Occupations* of the people have an influence upon their character and health. The facts should be obtained, at least, in relation to all males over fifteen years of age, and engaged in the principal professions and occupations.
6. The *Place of Birth* should be known, so far as to specify separately those born in the town or city where they reside, (to show the sanitary influence of locality) those born in the different States of the United States, and those born without the United States.
7. *Education* has an influence upon the sanitary condition of the people; and some facts regarding it should be known concerning all persons over 20 years of age. An answer to the question, "Can you read and write?"—will afford a simple and definite fact, and may be obtained concerning every person.
8. *House Accommodation* is quite important. The number of persons to a family, and the number of families and persons to a house, and the extent of their accommodations, should be known. Life and health are often affected by over-crowded dwellings.

9. *Means of Subsistence and Comfort* also have an influence upon the sanitary condition of a people. . . .
10. *Health*. Useful information concerning four special diseases,—blindness, deafness, insanity and idiocy,—has been ascertained in the last two censuses. The number of persons thus afflicted, as well as the number of paupers and criminals, should be known.

XIII. *We recommend that the Constitution of the State be so altered, that the State Census shall be taken in 1855, and at the end of every subsequent period of ten years.*

[Section discussion deleted to save space. Ed.]

XIV. *We recommend that the laws relating to the public registration of births, marriages, and deaths, be perfected and carried into effect in every city and town of the State.*

[Section discussion deleted to save space. Ed.]

XV. *We recommend that provision be made for obtaining Observations of the atmospheric phenomena, on a systematic and uniform plan, at different stations in the Commonwealth.*

The atmosphere or air which surrounds the earth is essential to all living beings. Life and health depend upon it; and neither could exist without it. Its character is modified in various ways; but especially by temperature, weight, and composition; and each of these modifications have an important sanitary influence.

[Discussions concerning the scientific aspects of air and meteorological data gathering in Europe have been deleted to save space, Ed.]

XVI. *We recommend that, as far as practicable, there be used in all sanitary investigations and regulations, a uniform nomenclature for the causes of death, and for the causes of disease.*

. . . Without such a uniform standard of comparison no just conclusions can be drawn. It would be equally proper to use Fahrenheit's thermometer in one place and Reaumur's in another, to estimate the comparative temperature of the atmosphere; or two different kinds of instruments as measures of weight and length, in other matters, as to use one name or classification of causes of death, or causes of disease, in one place, and a different name or classification for the same causes in another. Hence the reason for the above recommendation in a plan for a sanitary survey of the State will be apparent.

[A discussion of several disease classification systems has been removed to save space. Ed.]

XVII. *We recommend that, in laying out new towns and villages, and in extending those already laid out, ample provision be made for a supply, in purity and abundance, of light, air, and water; for drainage and sewerage, for paving, and for cleanliness.*

. . . It has been ascertained that the inhabitants of densely populated places generally deteriorate in vitality; and that, in the course of years, families frequently become extinct, unless recruited by a union with others from the country, or with other blood of greater vital force. This is a significant fact, which should be generally known. Cities are not necessarily healthy, but circumstances are permitted to exist, which make them so. . . .

1. "*Light*," says the Liverpool Health of Towns Advocate, "is necessary to health." Dr. Edwards, of Paris, has shown, that if tadpoles be deprived of light, they do not advance beyond that state of development. . . . Baron Humboldt strikingly corroborates this opinion, for he says, after a five years' residence amongst many American tribes, "I have not seen a single individual with a natural deformity." *We may thus conclude that abundance of light is essential to the proper development of form in man:* . . . if children, at the time of early growth, be deprived of this necessary agent, their development will be materially modified, and the foundation for a weak constitution will be laid, and consequent incapacity for labor, and tendency to disease superinduced. Dr. Edwards gives it as his opinion that "the want of sufficient light must constitute one of the external causes which produce these deviations of form in children affected with scrofula; which conclusion is supported by the observation, that this disease is most prevalent in poor children, living in confined and dark streets." . . .
2. *Air*. . . . Streets should be of sufficient width to permit a free circulation of air. Restrictions should be so imposed as to permit few lanes, alleys, and courts, and none that would so obstruct the circulation as to endanger the public health. Every place from which light is excluded, or into which pure air, in any desirable quantities, cannot at pleasure be introduced, should be pronounced unfit for habitation.
3. *Water*. "The following are the chief conditions in respect of water supply, which peremptorily require to be fulfilled:—
   a. That every house should be separately supplied with water, and that where the house is a lodging-house, or where the several floors are let as separate tenements, the supply of water should extend to each inhabited floor."
   b. That every privy should have a supply of water applicable as often as it may be required, and sufficient in volume to effect, at each application, a thorough flushing and purification of the discharge pipe of the privy."
   c. That in every court, at the point remotest from the sewer grating, there should be a stand-cock for the cleansing of the court; and

d. That at all these points there should always and uninterruptedly be a sufficiency of water to fulfill all reasonable requirements of the population."[30]

4. *Drains and Sewers* should be made to carry off water introduced in any way into cities and villages. If the surplus be permitted to remain, it often becomes stagnant and putrid and is then a fruitful source of disease. . . .

5. *Paving* is of great importance as a sanitary measure. The following are the conditions requisite for a good system:—

   a. Pavements should be made as impervious to fluids as possible, otherwise the subsoil remains moist, and becomes impregnated with matters deleterious to the purity of the atmosphere. All stone pavements should therefore be closely joined; and consequently those made of round boulders are inadmissible for sanitary purposes. Wood pavements are decidedly injurious to health. . . .

   b. Great care should always be taken to prevent the formation of pits and hollows [potholes. Ed.], which are always injurious to health, by permitting the retention of solid and fluid substances in state of decomposition, and presenting great obstacles to cleansing.

   c. All courts and passages should be *flagged* [given street signs. Ed.]; the common is inadequate for sanitary purposes in such localities.

   d. A complete reform should be effected in the manner of constructing street gutters. . . .[31]

6. *Cleanliness* in towns is of such immense importance to health—that it should constitute an indispensable part of sanitary police. The only safe rule is, to remove out of town, and out of a house, refuse as soon as it is produced. . . .

XVIII. *We recommend that, in erecting churches, and other public buildings, health should be regarded in their site, structure, heating apparatus, and ventilation.*

[Section discussion deleted to save space. Ed.]

XIX. *We recommend that, before erecting any dwelling-house, manufactory, or other building, for personal accommodation, either as a lodging-house or place of business, the owner or builder be required to give notice to the Local Board of Health, of his intention and of the sanitary arrangements he proposes to adopt.*

[Section discussion deleted to save space. Ed.]

XX. *We recommend that local Boards of Health endeavor to prevent or mitigate the sanitary evils arising from crowded lodging-houses and cellar-dwellings.*

Such places are universally acknowledged to be incompatible with health. . . .

XXI. *We recommend that open spaces be reserved, in cities and villages, for public walks; that wide streets be laid out; and that both be ornamented with trees.*

Such an arrangement would have a good effect upon the beauty and social enjoyments of the place; but it would have a greater effect upon its general sanitary condition. Vegetation would absorb much of the carbonic acid gas which is produced in so great superabundance in populous places, and thus render the air more fit for respiration. Open spaces also would afford to the artisan and the poorer classes the advantages of fresh air and exercise, in their occasional hours of leisure.

XXII. *We recommend that special sanitary surveys of particular cities, towns, and localities, be made, from time to time, under the direction of the General Board of Health.*

It is of great importance that the exact sanitary condition of every town in the State should be ascertained, that any causes unfavorable to health may be removed or mitigated. . . .

XXIII. *We recommend that local Boards of Health, and other persons interested, endeavor to ascertain, by exact observation, the effect of millponds, and other collections or streams of water, and of their rise and fall, upon the health of neighboring inhabitants.*

[Section discussion deleted to save space. Ed.]

XXIV. *We recommend that the local Boards of Health provide for periodical house-to-house visitation, for the prevention of epidemic diseases, and for other sanitary purposes.*

The approach of many epidemic diseases is often foreshadowed by some derangement in the general health; and, if properly attended to at that time, the fatal effects may be prevented. This is especially proper in regard to cholera and dysentery. . . .

XXV. *We recommend that measures be taken to ascertain the amount of sickness suffered in different localities; and among persons of different classes, professions, and occupations.*

Every person is liable to sickness. The extent of that liability, however, varies in different places and circumstances, and in the same place and circumstances in different ages and seasons. . . .

XXVI. *We recommend that measures be taken to the amount of sickness suffered, among the scholars who attend the public schools and other seminaries of learning in the Commonwealth.*

It has recently been recommended that ecology be taught in the public schools; should be universally approved and carried soon as persons can be found capable of teaching it.[32] Sanitary science is intimately connected with physiology, and deserves equal and even greater commendation as a branch of education. Every child should be taught, early in life, that to preserve his own life and his own health and the lives and health of others, is one of his most important and abiding *duties*. By obeying certain laws, or Acts, his life and health may be preserved; by disobedience, or performing certain other acts, they will both be destroyed. By knowing and avoiding the causes of disease, disease itself will be avoided, and he may enjoy health and live; by ignorance of these causes and exposure to them, he may contract disease, ruin his health, and die. Every thing connected with wealth, happiness and long life depend upon *health*; and even the great duties of morals and religion are performed more acceptably in a healthy than in a sickly condition. . . .

XXVII. *We recommend that every city and town in the State be required to provide means for the periodical vaccination of the inhabitants.*

The small-pox is a terrific disease; but it is almost entirely shorn of its terrors by the preventive remedy of vaccination. If a person is not vaccinated, there is more than two chances to one, that, if exposed, he will take the disease; but, if properly vaccinated, there is scarcely one chance in five hundred. Hence, the importance of this preventive measure, and the guilt of neglecting it. . . .

XXVIII. *We recommend that the causes of consumption, and the circumstances under which it occurs, be made the subject of particular observation and investigation.*

. . . The *causes of this disease*, and the means of removal, are the great objects of investigation; and they can be accurately ascertained only by an extensive series of systematic, uniform and exact observations of the external circumstances,—atmospheric, local and personal,—occurring in each case. And we cannot too strongly impress upon local Boards of upon the members of the medical profession, and others interested, the importance of making a united and energetic effort to obtain such observations concerning event case which occurs in every part of the Commonwealth. Near 3,000 cases, in this State, annually terminate in death; and if they were properly observed, for a series of five, ten, or more years, it is impossible to anticipate the good results might follow. . . .

XXIX. *We recommend that nuisances endangering human life or health, be prevented, destroyed, or mitigated.*

Nuisances are divided, in law, into two principal classes:—1. Those which affect the community, or the public, denominated *public nuisances;* and 2. Those which affect the rights or injure the property of individuals, denominated *private nuisances*. . . .

A street, highway, or bridge, is common property, and any obstruction, pit-hole, or defect, which endangers the lives of travelers, is a nuisance. . . . Those who cause them are liable to prosecution and damages.

There is another class of nuisances which are equally obnoxious. Every kind of trade or occupation,—any filth or other substances which corrupts the atmosphere,—every kind of food or drink that is unwholesome, though it should not produce immediate death or disease, if it endangers the health or gradually injures it,—is a nuisance; and every man who causes a nuisance transcends his right, and renders himself liable to prosecution. Boards of Health should make such regulation that no person should prevent any other person from enjoyment of life and health; and no artificial obstruction should be permitted, that may destroy or injure either.

XXX. *We recommend that measures be taken to prevent or mitigate the sanitary evils arising from the use of intoxicating drinks, and from haunts of dissipation.*

That intemperance is an enormous evil is universally acknowledged. That it is the cause of a vast amount of direct sanitary suffering,—of unnecessary sickness, and of unnecessary death,—to those who indulge in it; and of a still greater amount of indirect sanitary suffering and death to their associates, relatives, and dependents, is equally true. . . . Local Boards of Health, by a careful observation of the sanitary evils of intemperance, and the local and personal circumstances under which they occur, and by adopting and enforcing such salutary regulations as will remove or mitigate them, may confer an immeasurable benefit upon the people.

XXXI. *We recommend that the laws for taking inquests upon the view of dead bodies, now imposed upon coroners, be revised.*

In our judgment, every matter relating to life, to health, and to death, should, to some extent, come under the cognizance of Boards of Health. The cause of the death of every person who dies should be fully known to them; in their offices records of inquests upon dead bodies should be preserved. . . .

XXXII. *We recommend that the authority now vested in justices of the peace, relating to insane and idiotic persons, not arrested or indicted for crime, be transferred to the local Boards of Health.*

By present laws of the State, no insane or idiotic person, other than paupers, can be committed to any hospital or place of confinement, except on complaint, in writing, before two justices of the peace, or some police court. Paupers may be committed by the overseers of the poor. By these proceedings, this unfortunate class of persons appear on the records as criminals, while they are guilty of no crime, unless the possession of an unsound mind be considered one. . . .

XXXIII. *We recommend that the general management of cemeteries and other places of burial, and of the interment of the dead, be regulated by local Boards of Health.*

. . . There are few if any states or countries, where more excellent regulations relating to the burial-grounds and the interment of the dead exist, where the burial is conducted with more propriety, and where greater respect is paid to the deceased. . . . To accomplish these objects, there are several matters to be considered.

1. Plans for obtaining a *place of burial*. Several have existed in this State. One plan permits a family to select a private place of burial on its own estate. This is adopted in some parts of this Commonwealth, especially in the western and southern counties, but we cannot but regard it as highly objectionable. . . . Another plan allows proprietors, under the act of incorporation, to sell lots, or places of burial, under such regulations as they choose to make. This is of recent date, and originated at Mount Auburn. . . . Another, and the more general plan, vests the ownership of all burial grounds in the town, which grants to families and to individuals, sometimes gratuitously, and sometimes for a consideration, rights for family lots, for tombs, and for single graves.

   The place of burial should be selected in a somewhat secluded, and not in the most conspicuous part of the town, and should be combined with such natural scenery as will tend to inspire those feelings of solemnity and decorum which properly belong to the "city of the dead." It should not be where it would ever be liable to be encroached upon for buildings, roads, or any other purpose; but where the tenants may remain forever undisturbed in their quiet resting-place. And it should be large enough to meet the wants of the probable future growth of the town which it is designed to accommodate. Parts of such a cemetery might be assigned to a particular religious denomination, and, if desired, specially consecrated for its use. It should *never be within a populous city or village*. . . .

2. There are two *modes of interment* practiced in this State; one in graves, and the other in tombs. We much prefer the former. Dangerous gases often escape from tombs, when insecurely closed, or when often opened for new deposits. . . .

3. "Wakes," which are sometimes held over the bodies of the dead, by the foreign population, should be prohibited as improper, and dangerous to the public health and to good morals. In cities and populous villages, public reception-houses should be provided, and placed under proper regulations, to which dead bodies might be removed, from families living in a single room, or from a public boarding or lodging house, or from other places, where it would be inconvenient or dangerous to the public health to permit them to remain. . . .

4. Local Boards of Health should appoint intelligent and competent health officers, undertakers, and others, who should be required to ascertain the sanitary condition of every family in which a death has occurred. . . .

5. Boards of Health should make an exact survey and plan each burial-ground in their respective towns, on which should be drawn and numbered separately, each family or personal lot, each tomb, and each grave; and these numbers be entered in a record-book, and against each the name of the individual or individuals interred therein. . . .

XXXIV. *We recommend that measures be taken to preserve the lives and the health of passengers at sea, and of seamen engaged in the merchant service.*

Vessels at sea are the floating habitations of living beings; and in these, as in dwellings on the land, the air may be corrupted by over-crowding, filth, and other causes, and thus become a fruitful source of disease. . . . Sanitary improvement was early introduced on board ships, as we shall presently show; and a great number of human lives have consequently been saved. In no department of social economy can preventive measures have a greater influence. Boards of Health might do a good service to humanity, by issuing a simple and judicious code of sanitary regulations for ships.[33]

XXXV. *We recommend that the authority to make regulations for the quarantine of vessels be intrusted to the local Boards of Health.*

[Section discussion deleted to save space. Ed.]

XXXVI. *We recommend that measures be adopted venting or mitigating the sanitary evils arising from emigration*.

This recommendation involves one of the most momentous, profound, and difficult social problems ever presented to us for solution. . . .

The State should pass suitable laws on the subject, and the local Boards of Health should carefully observe evils in all their sanitary bearings and relations. We however, suggest,—

1. That emigration, especially of paupers, invalids, and criminals, should, by all proper means, be discouraged; that misrepresentation and falsehood, to induce embark in passenger-ships, should be discountenanced and counteracted.

2. That ship-owners and others should be held to strict accountability for all expenses of pauper emigrants: existing bonds for their support should be strictly enforced.

3. That a system be devised by which all those who introduce them, by water or by land, should be required to pay a sufficient sum to create a general sinking fund for the support of all who may require aid in the State, at within five years after their arrival.

4. That such a description of each emigrant be registered as will afford the means of identification of anyone, at and in any place, within five or more years after arrival.

5. That encouragement be given to emigrate from this State, where there is little demand for labor, to places; and that associations be formed among for settling on the public lands of the United States.
6. That efforts be made, by all proper means, sanitary and social condition of foreigners, and to among them habits of cleanliness and better modes of living.
7. That our system of social and personal should be revised and remodeled, and that a general plan be devised which shall bring all the charities of the city, county and state, under one control, and thus prevent giving and imposition.
8. That an establishment for paupers, including a farm and workshops, be formed in each county in the State paupers might be sent, and where they be required to labor, as far as practicable, for their support.

II. Social and Personal Measures Recommended

Most of these recommendations may be carried into effect without any special legislative authority, State or municipal.

XXXVII. *We recommend that a sanitary association be formed in every city and town in the State, for the purpose of collecting and diffusing information relating to public and health.*

[Section discussion deleted to save space. Ed.]

XXXVIII. *We recommend that tenements for the better accommodation of the poor, be erected in cities and villages.*

[Section discussion deleted to save space. Ed.]

XXXIX. *We recommend that public bathing-houses and wash-houses be established in all cities and villages.*

[Section discussion deleted to save space. Ed.]

XL. *We recommend that, whenever practicable, the refuse and sewage of cities and towns be collected, and applied to the purposes of agriculture.*

The refuse and sewage of cities and villages are of great value as manure; and plans have been devised abroad to collect and apply them for agricultural purposes. Companies have been formed, estimates made, and experiments tried, to test their value and to devise the best means by which they might be to their great value all agree; but the different plans of collecting and distributing them, seem not as yet so fully tested as to warrant a recommendation of any particular one in preference to others. . . .

[A discussion on the value of manure[34] has been deleted to save space. Ed.]

XLI. *We recommend that measures be taken to prevent as far as practicable, the smoke nuisance.*

[Section discussion deleted to save space. Ed.]

XLII. *We recommend that the sanitary effects of patent medicines and other nostrums, and secret remedies, be observed; that physicians in their prescriptions and names of medicines, and apothecaries in their compounds, use great caution and care; and that medical compounds advertised for sale be avoided, unless the material of which they are composed be known, or unless manufactured and sold by a person of known honesty and integrity.*

The sanitary effects of patent medicines and other nostrums, advertised for sale, is one of the greatest evils of the present day. If the people were aware of the immense amount of such sales, and of the impaired health, the ruined constitutions, and the premature deaths, which they occasion, they would be astounded. An insatiable desire to make money, frequently without regard to the justice or morality of the means, on the part of the manufacturers and venders, and an inclination to do something for the relief of real or imaginary suffering, and an unenlightened belief, on the part of purchasers, that what is advertised as true must be true, are the prominent causes of this monstrous evil. . . .

XLIII. *We recommend that local Boards of Health, and others interested, endeavor to prevent the sale and use of unwholesome, spurious, and adulterated articles, the public health, designed for food, drink, or medicine.*

. . . Prodigious quantities of spurious articles, of food, drink, and medicine, which are highly daily palmed upon the public by mercenary and fraudulent manufacturers and dealers. And it is generally concluded that a great amount of disease and numerous premature deaths are thereby produced.

Food is adulterated in various ways. . . . Bread is often adulterated with alum, carbonate of ammonia, carbonate of magnesia, sulphate of copper and zinc, &c., to improve its appearance, when made of flour of inferior quality. Butter and cheese are often poisoned with coloring matter. Milk is watered, sugar sanded, and various other intentional frauds are practiced. Unintentional adulterations may also sometimes take place by means of keeping or cooking different kinds of food.

Drink is also very extensively adulterated. It is said that very little of what is sold as champagne wine is made from the juice of the grape, but is a deleterious compound of other substances. Few of other kinds of spirituous liquors go to the consumer in a pure state. It is the opinion of eminent temperance reformers that one of the principal causes of the sad sanitary effects of intemperance arises from the poisonous substances compounded with the pure spirit and taken in the intoxicating cup. Other kinds of more ordinary drink, not intoxicating, and even water itself, may be adulterated and rendered unfit for use.

Drugs and medicines have been adulterated by the foreign producer, manufacturer and dealer, expressly for the American market, and vast quantities of such articles have been imported and sold in this country. Some of our own producers, manufacturers and dealers, also, have been guilty of a similar fraud. By careful study the properties and mode of operation of the various articles used as medicine have been ascertained, and the intelligent, conscientious, curative physician, can estimate their effect with some degree of accuracy. It is necessary, however, to enable him to do this successfully, that they should be of known purity and strength. If spurious, of inferior quality, or adulterated with other substances, not contained in the genuine article, disappointment follows, and the patient suffers and perhaps dies. This result may happen under the advice of the best curative medical skill, and life may be, and has actually been lost, from some defect existing alone in the medical remedies used. A mere statement of this fact will render obvious the importance of this recommendation. . . .

The Revised Statutes of Massachusetts contain the following provisions of law on the subject:—

"SECT. 1. If any person shall knowingly sell any kind of diseased, corrupted, or unwholesome provisions, whether for meat or drink, without making the same fully known to the buyer, he shall be punished by imprisonment in the county jail not more than six months, or by fine not exceeding two hundred dollars.

SECT. 2. If any person shall fraudulently adulterate, for the purpose of sale, any substance intended for food, or any wine, spirits, malt liquor, or other liquor, intended for drinking, with any substance injurious to health, he shall be punished by imprisonment in the county ail not more than one year, or by fine not exceeding three hundred dollars, and the articles so adulterated shall be forfeited and destroyed.

SECT. 3. If any person shall fraudulently adulterate, for the purpose of sale, any drug or medicine, in such a manner as to render the same injurious to health, he shall be punished by imprisonment in the county jail not more than one year, or by fine not exceeding four hundred dollars, and such adulterated drugs and medicines shall be forfeited and destroyed."

This act gives sufficient legal authority to prevent the evil. If it be carefully observed, and only those dealers who are properly qualified for their business, and are of known honesty and integrity, receive public patronage, and those of an opposite character are discountenanced, and instances of flagrant abuse prosecuted and punished, it may be reasonably supposed that the evil will greatly diminish.

XLIV. *We recommend that institutions be formed to educate and qualify females to be nurses of the sick.*

It is hardly necessary to commend the importance of good nursing in the cure of disease. Let a physician be ever so skilful, and prescribe his remedies with ever so much care and sagacity, if the nurse does not follow his directions, or if she neglects her duty, or performs it unskillfully, or imperfectly, or with an improper disposition, the remedies will be unsuccessful, and the patient will suffer; and perhaps life is lost as the consequence. On the other hand, let a physician of moderate capacity prescribe with ordinary skill, if his orders are carried into execution by a nurse, who understands, loves, and conscientiously discharges her duty, the patient is relieved, and life is preserved as the consequence. It is thus that bad nursing often defeats the intentions of the best medical advice, and good nursing, often supplies the defects of bad advice. Nursing often does more to cure disease than that the physicians himself; and, in the prevention of disease and in the promotion of health, it is of equal and even of greater importance. Many and many a life, which might have been saved, has been lost in the hands of quack nurses, as well as in those of quack doctors. . . .

XLV. *We recommend that persons be especially educated in sanitary science, as preventive advisers as well as curative advisers.*

The great object of sanitary science is to teach people the causes of disease,—how to remove or avoid these causes,—to prevent disease,—how to live without being sick,—how to increase the vital force,—how to avoid premature decay. And one of the most useful reforms which could be introduced into the present constitution of society would be, that the advice of the physician should be sought for and paid for while in health to keep the patient well; and not, as now, while in sickness, to cure disease, which might in most cases have been avoided or prevented. . . .

In connection with these sentiments, in which we fully concur, there is another matter deserving investigation, which has as great if not greater influence on the sanitary condition of the people. We allude to the numerous incompetent, uneducated medical advisers, who are employed as curative physicians. . . . We have, besides physicians educated according to the roles of some state medical organization, or some medical school, the homeopathic, the hydropathic, the analytical, the Thomsonian, the botanical, the eclectic and electrical, the mesmeric, the pathetistic, the electro-biologic, the chrono-thermal, the Indian, and very many other denominations of physicians, each putting forth their own system as the only sure one for the cure of all diseases. Looking superficially at all these classes, it would seem that at no period has medical practice been more unsettled. There are men of integrity and skill in these different denominations; but there undoubtedly exists in most, if not all of them, a vast amount of practice which is injurious, or does violence to health and life. . . .

XLVI. *We recommend that physicians keep records of cases professionally attended.*

The science of medicine, like most other sciences, is founded upon facts. Many of these facts are stated in the recorded observation and experience of the profession, handed down to us in the accumulated medical literature of the age. . . . After consulting with several different physicians, whose opinions and approval are entitled to all respect, we propose . . . for adoption . . . [A patient chart. Ed.] . . . that it may be conveniently carried about by the practitioner, thus allowing him to have at hand the means of entering his observations *in the place* and *at the time* they are made.

Such a register would enable the physician to give the certificate of the cause of death, required under the registry laws, and also to give the amount of sickness suffered in any family he visits. . . .

XLVII. *We recommend that clergymen of all religious denominations make public health the subject of one or more discourses annually, before their congregations.*

[Section discussion deleted to save space. Ed.]

XLVIII. *We recommend that each family keep such records as will show the physical and sanitary condition of its members.*

[Section discussion deleted to save space. Ed.]

XLIX. *We recommend that parents, and others to whom the care of those in infancy and childhood are intrusted, endeavor to understand and discharge their duties so that a good foundation may be laid for vigorous manhood and old age.*

The management of infancy and childhood has an immense influence upon the health, vigor, and continuance of life. . . .

L. *We recommend that individuals make frequent sanitary examinations of themselves, and endeavor to promote personal health, and prevent personal disease.*

If there is a fault in the printed discussions of sanitary reformers, it is in attaching too much importance to public and too little to personal measures, for the promotion of health. . . . Every person should *know*, by his own observation and experience; his own capabilities and his own liabilities; and make matter of preserving his health and continuing the same care and prudent forethought, and apply to it the same intelligence and sagacity, that he uses in any or all of his ordinary affairs. . . .

Our persons should be *protected*, and kept in uniform temperature, by clothing of the right kind, properly made, and worn at such times, in such a manner, and in such quantities, as are best adapted to promote health. Disease should not be allowed to invade the system by means of too little or too much clothing, or through any other defect or imperfection; but each person should wear just such clothing, at all times, as will involve the least risk, and produce the greatest vigor and physical enjoyment.

Our persons should be *nourished* by food of the right kind, and in such quantities, as will promote the greatest vigor. We should "eat that we may live, not live that we may eat;" take food to nourish us, not to satiate a depraved appetite; and adapt our food and our regimen, at all times, to the present physical and sanitary condition of the body. When debilitated and fatigued, we cannot take with impunity the same kind or quantity of food as when in a different condition.

Our persons should be *preserved* and *strengthened* by wise and uniform care and training. We should cleanse our persons by daily ablutions, properly applied, at suitable times, and of the right kind and temperature; *strengthen* our persons, physically and intellectually, by regular and progressive, not transient and excessive, exercise and labor, at such times, to such and in such places, as will be most invigorating; and should *refresh* our persons by rest and sleep, at proper times, in right places, by suitable means, and in sufficient quantities.

What is right and suitable and proper, in each of these cases, must be determined by each one's own intelligence, observation, experience, feelings, and condition, ascertained by himself. If careful personal sanitary examinations were frequently made in this way, and personal health was guarded and improved by these means, we should hear less of the ravages of cholera; typhus, and other epidemics, and of isolated sporadic diseases.

IV. Reasons for Approving the Plan Recommended

We have presented, in the preceding pages, some of the principal measures that have occurred to us as worthy of being embraced in a plan for a sanitary survey of the State, which we recommend for adoption. We might have included other collateral subjects, and might have given a more full explanation and illustration of those already presented, but the occasion did not seem to require it or make it necessary. Our design will have been accomplished if our recommendations have been explained sufficiently to be generally understood and capable of being reduced to practical operation. We claim for the whole plan, and for each part of it in connection with the other parts, a careful consideration before judgment is passed upon it, and when so considered we have great confidence that we shall have the approval of all candid minds. We have already given, in the illustrations of the several recommendations, many reasons for their approval; and they are sufficient, it is supposed, to incline most intelligent minds in their favor; we might safely leave the subject here without further discussion. There are, however, some general considerations in favor of the plan which we deem it proper to present.

I. *It should be approved because it is* A PRACTICAL MEASURE.

The great *outline of the plan* is the Establishment of a Central General Board of Health for the whole State, and a Local Board of Health for each city and town in the State; each to be composed of competent men, who are to have general superintendence of all matters relating to the public health within their respective jurisdictions. These Boards, having the assistance and cooperation of the people in all parts of the Commonwealth, would be able to bring to bear, by practical, systematic, uniform, and efficient plan, a vast number of minds and a great amount of intelligence upon the subject of health, and upon the causes and prevention of disease; and it is impossible to foretell the immense advantages which might result from the facts they might collect, and from the discoveries they might make, relating to the number of lives saved, the prolongation of the periods of human existence, and the diminution of human suffering.

In the preparation of the plan, we have desired, on the one hand, to avoid too much, and on the other too little complication and detail. The proposed act, which is the main legal foundation of the plan, is designed to occupy the middle ground between these two extremes. It contains no provisions which seem to us unessential, and it is designed to contain all such as are necessary. So important a matter cannot be provided for by a few general sections. It must be made clear and simple; and considerable detail is required for this purpose, otherwise it cannot be understood, and easily introduced into all the towns in the State. It is believed that if the act were passed and put into operation by such Boards of Health as might and ought to be appointed under its provisions, nothing would be required but ordinary intelligence and attention to make it successful, and this every measure must have or it will be useless. If this act should become a law, several of the recommendations must be carried into effect; others may or may not be, as circumstances may render it necessary or expedient. The XIIth, XIIIth, XVIIth, XXXIst, XXXIInd, and XXXVIth, would require additional legislation to carry them into operation. The recommendations relating to social and personal matters are designed for the general good, and come in aid of the others without special legislation. They may or may not be adopted, according to inclination of those interested. And what is the design, what are the purposes of this measure? What will it probably accomplish, if carried into execution?

It would save life. It has been well said:—"In England alone, the average annual number of deaths from disease is, in round numbers, 300,000, while that of deaths from the mere decay and exhaustion of the human frame by the progress of time, is only 35,000. In the difference between these two numbers we see the vast and vital field in which the sanitary reformer proposes to work. That disease shall ever be entirely exterminated, is of course beyond the belief or hope of the most sanguine. But every disease has somewhere its specific and efficient cause,—and that these causes can be removed or much weakened in their action, in very many instances, is not only within the bounds of hope, but has been satisfactorily proved. When sanitary legislation gives us its successful results, they will be represented by the reduction of the number of those who die of disease in their early days, or in the prime of life—and in the increased number of those who have completed their allotted course in health, and been peacefully gathered to their fathers. Accordingly, sanitary improvements have not directly in view the extension of the natural period of human life, but only the removal of influences which artificially curtail it."

Similar illustrations may be derived from observations among us. In Massachusetts, during the seven years covered by Registration Reports, 64,510 deaths, in all the counties except Suffolk, were recorded and returned to the office of the Secretary of State; and of these, 4,414, or 6.84 per cent. only, recorded as having died of old age, and 93.16 per cent. from diseases and other causes.

In Boston, during thirty-nine years, 1811 to 1849 inclusive, 62,431 deaths took place, of which 2,079, or 3.33 per cent. only, were from old age, and 96.67 per cent. from diseases and other causes; and for the year 1849 it appears still more unfavorable, being 5,079 from all causes, and 95, or 1.87 per cent. only from old age, and 98.13 per cent. from other causes. Is it not a practical measure to prevent some of this great amount of disease, and assist some of these lives that they may grow old, and die only because they *are* old?

We have constructed and given a very important table, showing the law of mortality for Boston, at three periods, and also for a district of the average health of the country towns in the State. By this table it appears that 1½ per cent., or 1 in 67 of the population, is about the rate of mortality for the interior healthy towns in New England. In some towns it rises above and in others falls below that rate; but that may be assumed as a healthy standard. This is nearly the rate of the healthy districts in England. It also appears that in Boston, during the last nine years, the portion of deaths were, on the average, 2.53 per cent., or 1 in 39. And by the report of the City Registrar they were, in at the rate of 3.84 per cent., or 1 in 26 of the 132,000. If Boston had suffered an annual loss by death of 1½ per cent., equal to the average healthy country towns, instead of 2.53 per cent., there would have been on the average for the last nine years, 1,715 deaths annually, instead of 2,903; showing an excess of 1,188 unnecessary. And by applying the same rule to the year 1849, it will give 1,980 deaths only, which should have taken place, instead of 5,079, showing an excess, for that year alone, of 3,099 unnecessary deaths! and this is on the supposition that the rate may remain at 1½ per cent., when it is believed to be possible to raise the public health to a state even better than that. What Boston suffers, in so great a degree, is suffered, to a greater or less extent, in all places, city and country. Very many country towns suffer great unnecessary mortality; and is it not a practical measure to prevent as much of this excess of deaths as possible?

It would prevent sickness. We have stated that the estimated rate which sickness is supposed to bear to the population is double the rate per cent. of the annual deaths. This rule, if applied to our population, would indicate, in the opinion of some, too much, and of others too little sickness. But assuming it to be nearly the average, until we get more perfect returns, let us make the application. The average number sick during the whole year, in a healthy country town, is ($1\frac{1}{2} \times 2$) 3 per cent. of the population; and in Boston for the last 9 years (2.53×2) 5.06 per cent., and for the year 1849 (3.84×2) 7.68 per cent. According to this rule, if Boston had suffered no more than a healthy country town, she would have had but 3,960 persons constantly sick, or suffered that number of years' sickness in the aggregate, instead of 9,837; showing an excess of unnecessary sickness, for that year only, of 5,871 years!

Applying the same rule to the country towns, it will show an immense though not so great a proportion of unnecessary sickness. Estimating the population of the State at 800,000, and assuming it to enjoy a healthy standard, there would be 12,000 deaths annually, and 24,000 persons constantly sick. But the deaths returned in the counties other than Suffolk, were 11,346 for the year ending May 1, 1848, and very many were not returned at all. An abstract of the returns of deaths for 1849, has not yet been made, but when it is made we have no doubt that it will show an annual mortality as high as 21 per cent., or an excess in the whole State of 6,000 unnecessary deaths, and of 12,000 years of unnecessary sickness!

It would increase the vital force. We have presented the loss of life and the amount of sickness as two of the great evils which the people suffer. Another is found in the vast amount of impaired health and physical debility which exist among those not actually disabled by sickness. Many, very many, move feebly about, discharging imperfectly the great life, and have not the capacity to perform the labor which perfect health allows.

"The aggregation of all the physical powers, the original organization, the united energies of the nutritive, respiratory, cutaneous, locomotive, and nervous actions, and the predominance of the vital over the chemical affinities, cooperate in the production of *vital force*; and these together make up what is commonly called the *constitution* of man,—that is, his power for labor or endurance,—his power of accomplishing his purposes: or resisting the causes of injury.

"This constitution, or this quantum of vital force, may be considered as the *capital of life*, with which man operates, does all his work, enjoys all his pleasures, and sustains in his present being.

"Some few persons have only vital force sufficient to sustain life. They can digest their food, and perform functions necessary for the replenishment of the exhausted powers, and no more. They can only keep their vital machines in operation. But most persons have more than this. After supplying their natural wants, and raising the power of the machine to its highest healthy point, then deducting vital force necessary for these from the whole constitutional force, there is in them a surplus of energy left to be disposed of otherwise; and this may be expended, at their own actions of the muscles or of the brain, for profit or for pleasure.

"If the constitutional power is considered as the capital of life, this surplus energy may be considered as the *income of life*. This may be expended daily, and yet leave unimpaired. But this expenditure must be limited, in each day, to the quantity of vital force that is generated by day's nutrition, and each night's sleep.

"This constitution, or quantity of vital force, must differ in different persons, and in some it differs very widely. There are differences in the primordial elements, in the original organization, in the distribution of strength through the several organs, in the tenacity of the vital principle, and in the early development of the powers.

"There are also differences in the subsequent management of the system, and in the appropriation of the surplus energies. The animal organization is first determined by the Creator; the constitution is next developed by those who have the care of childhood and youth, and then it is entrusted to the hands of man himself, for preservation and for use. The Creator does not retain absolute control over the organs, nor has He endowed them with a certain and irresistible force, by which they shall supply their own wants, perform their functions, and regulate their actions in the manner which is best for the whole. All of these admit of various degrees; and, in this broad latitude, each one must seek out for himself that degree which is best, and determine what degree shall be allowed."[35]

Here then is the immense field to which our measure applies. Its purpose is to reduce this great number of deaths, to prevent this vast amount of sickness, and to raise the general standard of health as high and even higher than that of the most healthy districts; and this it proposes to accomplish by giving to the legislature an exact knowledge of the condition of the people; by the passage of useful laws for the promotion of their welfare; by giving to the physician a better knowledge of the causes and prevalence of diseases, that he may better adapt his remedies to their prevention and cure; and by diffusing among all classes of the people facts concerning life and health, and the general principles of sanitary science, and by leading them to make progress in sanitary improvement.

We do not suppose, if our measure should be adopted, that these great improvements will immediately take place, neither do we suppose that the time will ever come, let our sanitary regulations be ever so well matured, when no human being will die of any other cause than old age,—the wearing out of the human machine. But what we anticipate is a gradual sanitary improvement, a gradual removal and avoidance of the causes of disease, a gradual diminution of human suffering and a gradual reduction of the number of premature and unnecessary deaths. And there can be no objection to aiming at abstract perfection, and to continuing our efforts at reformation until it is attained.

That our measure *will accomplish what it proposes*, if put in operation, there is abundant evidence in history of sanitary experience. The recorded facts concerning the causes of disease, and concerning disease itself, in all ages and in all countries, prove it.

[Examples from England[36] and quotations from American physicians and philanthropists[37] have been deleted to save space. Ed.]

The opinions of a large number of professional men whom we have had personal intercourse, fully coincide with those here recorded; and we are led to the startling conclusion that *half of all the diseases and half of the deaths* that place might have been avoided! It is unnecessary to bring further proof of a truth so well established. There is scarcely any person who, in a retrospect of his own life, number instances of sanitary suffering in himself, which he might have avoided had he understood and observed the laws of health and life. Our measure then is not a visionary, but a simple, everyday practical reality, comprehensible, and applicable to all persons, in every place, and at all times.

II. *It should be approved because it is* A USEFUL MEASURE.

If the important practical results which have been detailed, would follow the adoption of our plan, it is necessary that anything further be said to show that it is a useful measure. To save life, to prevent sickness, and to invigorate the human frame, are its objects; and none can be of greater utility.

It would give the State a knowledge of its inhabitants. Hasty legislation, based upon imperfect knowledge, is one of the evils of this republic. It prevails, to a greater or less extent, in all the legislatures, national, state and municipal. It is the practice of some governments, when measures deemed worthy of legislation are proposed, to appoint a commission or committee to make a thorough investigation of the whole subject, and to report the facts and the evidence. A bill is then carefully drawn, based upon the facts thus disclosed, and adapted to the exigencies of the case. This is enlightened, effective, useful and economical legislation. England is much indebted for her greatness and power to this practice; and her example, in this respect, is worthy of imitation. The very reverse of this, however, too often happens in the United States. We too often legislate first, and obtain the facts, if we obtain them at all, afterwards. An exact knowledge of the circumstances of the people, is the surest basis for correct and useful legislation.

It would aid the physician. This would be done in various ways. The information obtained would be of immense consequence in giving him exact knowledge of the causes and prevalence of different diseases. This knowledge would greatly aid him in applying his remedies for prevention and cure. Instead of partial facts, obtained for a partial purpose, upon which to ground his theories, he would have a vast collection of impartial facts, truthfully gathered, for no other purpose than the promotion of truth. On such a basis he might construct a much better theory in medicine, and devise a more rational, philosophical system of remedies.

But there is another purpose which they would secure in this relation. One of the most trying circumstances in the life of a conscientious physician, is believed to be the capricious and unfounded judgment which the people often pass upon his skill and professional services. This opinion is frequently the result of accident or prejudice, combined with imperfect knowledge or entire ignorance, and would be changed if the people were better educated in sanitary science. This is an interesting consideration, and might be abundantly illustrated in the experience of every physician; but the mere suggestion is deemed sufficient for our purpose, to show that this is a useful measure to the medical profession.

It would benefit the people. We have already alluded to the murderous imposition which is practised upon a credulous people, by pretenders to medical skill, in curing disease, and by mercenary dealers in injurious nostrums and drugs. This matter may be again alluded to for a more general purpose. Though health is a matter in which every person is directly interested, yet there is scarcely any subject on which so much ignorance generally prevails. When well enough to do without medical advice, we are too apt to neglect to inform ourselves as to the means of avoiding the contingency of sickness. But when attacked with real or imaginary sanitary ills, no people are more liable to err, or can be more easily imposed upon. The body is subjected to experiments, by new advisers and new remedies, come from whatever quarter they may; and faith is put in certificates, which perhaps have been forged. Many, very many, are thus drugged to death, either by the blind guides of their own uninformed minds, or the unfounded pretensions of others. The object of this measure is to diffuse, among all classes of people, more enlightened views of life, health and disease. In this way it is believed numerous lives might be saved, a great amount of sickness prevented, and a corresponding amount of suffering avoided. Is not this a useful purpose?

III. *It should be approved because it is* AN ECONOMICAL MEASURE.

The expense of preventive sanitary measures is the most common argument brought against their adoption. Epidemics are considered by the ignorant as evils which it is useless to attempt to prevent; and among the better informed, a false idea of economy, which has sometimes led to the most fatal results, has been the ground of resistance to measures which were necessary to save life. It should, however, be known that public expenditures cannot be avoided during the prevalence of an epidemic disease. Money must be spent, either in saving life, or in the maintenance of pauperism, widowhood, and orphanage. In this case economy is on the side of humanity, and the most expensive of all things is to do nothing.

Debility, sickness, and premature deaths, are expensive matters. They are inseparably connected with pauperism; and whenever they occur they must, directly or indirectly, be paid for. The city or town must pay for the sick man's support for his food and clothing, for medical attendance on him during life, and for the support of his widow and children (if he leave any) "after his death. A town in which life is precarious pays more taxes than its neighbors of a different sanitary character. An individual who is unable to perform a large amount of labor or no labor at all, is a less profitable member of society than one who can do whatever vigorous health allows.

"It is for the interest of the public at large, no less than for the happiness of the few immediately interested in each human being, that the life once breathed should, if possible, be preserved, until it is released by the natural wearing away of its earthly tabernacle. We all know that, in the common sense of the term, a short-lived population is generally a surplus population,—not only because those who are reckless of preserving life, will be careless of all its obligations, and will be poor and vicious, but because the tendency of early deaths is chiefly to shorten the existence of those who produce more than they consume, and to increase the number of those who must be dependent on the charity of others. 'A cholera widow' is a significant expression occasionally used by the Board of Health, to indicate one who has been thrown on the parish by the death of that husband who, if he had not been prematurely cut off, might have supported her for years, and left his children old enough to earn bread for themselves. Many communities are now thus paying, in alarmingly swollen poor-rates, for the short-sighted selfishness which made them grudge the cost of precautionary arrangements."[38]

[Examples from the cholera epidemic[39] have been deleted to save space, Ed.]

The expenses and losses entailed by a neglect of sanitary measures may be classed under the following heads:—1. Expenses imposed upon the poor, by loss of work or of situations, for medical attendance and medicine, for nursing, for funerals, for the support of widows and orphans, and for other purposes. 2. Expenses imposed upon the tax-payers, for the support of those who are unable to support themselves, besides their own increased expenses arising from a bad sanitary condition. 3. Burdens imposed upon the charitable, for the support of hospitals, dispensaries, and for other more general or special charities. 4. A loss sustained by the state, in consequence of the diminished physical power and general liability to disease. 5. Expenses imposed upon the community, by the crimes arising from the unfavorable physical circumstances by which the laboring poor are surrounded, and which lead with certainty to their moral degradation. Various estimates have been made of these expenses, some of which, as stated by Lord Morpeth, we have already noticed, (p. 44).[40]

Attempts have been made to show the pecuniary advantages which would result to Massachusetts by the adoption of an efficient sanitary system. The subjoined is given as an estimate, which we believe would fall far below the reality. The number of unnecessary deaths the past year, has been estimated (p. 245) at 6,000, and of cases of unnecessary sickness at 12,000. This is a direct pecuniary loss to the State. If each of these 6,000 persons had been saved, and had lived 18 years, which may be taken as the average length of the labor period of life; or if the whole 18,000 persons who died in the State could have lived, on the average, six years longer than they did, (and who will say that they might not more than that period?) then we have 108,000 years of lost labor on their account, which may fairly be estimated at $50 each per annum. The cost of 12,000 years of unnecessary sickness may be estimated at $50 each, and the lost labor of the sick at $100 each. Then there are the public paupers, widows and orphans, made so by the premature deaths of relatives, which cannot be estimated at less than 6,000, at $1 per week. According to this calculation we have—

Loss of 108,000 years of labor, at $50 per annum	$5,400,000
Cost of 12,000 years of sickness, at $50 per annum	600,000
Lost labor of the sick, at $100 per annum	1,200,000
Cost of supporting 6,000 widows and orphans, at $52 per annum	312,000
Total annual loss	$7,512,000

There are other expenses and losses which might be avoided. The General Board of Health, by their superior sources of information, would be able to suggest to the local Boards of Health, and to others interested, the best arrangements and regulations for different objects of sanitary improvement; and many expenses now incurred for want of such information would be avoided. Many works, public and private, have been constructed at great expense, which are nearly worthless in a sanitary view, and might have been dispensed with if a better plan had been known. It has been well said “that it costs more money to create disease than to prevent it; and that there is not a single structural arrangement chargeable with the production of disease that is not in itself an extravagance.”

And what *would be the expense of the measure*? If the act we propose should become a law, the expenses of the General Board of Health must be provided for by the State; and they would be nearly as follows, annually:—

For the salary of the Secretary of the Board, say—	$2,000
For contingent expenses, including the expenses of the Board, printing, stationery, &c.—	1,000
Total	$3,000

The services of the clerks in making abstracts of a census of the inhabitants and of the returns under the registration system, and for other services, would cost no more, if prepared under the direction of the Board, than they now cost in the office of the Secretary of State. This then would be the expense to the State; and in the cities and towns which now have a Board of Health, and do anything for the sanitary fare of the inhabitants, no more expense would be the same service than is now paid.

This would be a wise expenditure of money. According to the estimate above presented, the State suffers, from its imperfect sanitary condition, an unnecessary annual loss of than 7½ millions of dollars! and this arises, partly at least, from the non-adoption of a measure which will cost but $3,000. If saved, it would add that amount to the wealth of the State, besides the indefinite amount of increased happiness which would accompany it. Should anyone consider this an extravagant estimate, let him reduce it to 3 millions, more one half, and then the relation of expenditures to the savings, or to the income, will be as *one dollar to one thousand dollars*! And even if nine tenths of this latter sum be deducted, it be like paying out *one* dollar, and receiving back again *ten* as the return profit! What more wise expenditure of money can be desired?

Look at the able report of the State Auditor for 1850, and compare it with any expenditure of the State, or compare it with any measure that has been introduced for consideration, and few, if any, can be found of greater expediency, propriety and usefulness, or that will contribute more to the prosperity and welfare of the people of the Commonwealth. Massachusetts "has required annual returns of information to be made and published, concerning pauperism and crime, banks and insurance companies, agriculture and other matters. She has indirectly offered premiums for the best farms, and the best productions; the best implements for manufactures, and the best articles produced; and has paid to agricultural societies, for these objects, since 1830, the sum of $123,319.18. She has instituted scientific surveys—astronomical, trigonometrical, geological, botanical, and zoological—has ascertained the ornithology, the ichthyology, and the entomology of State; and has expended, for these surveys, since 1830, the sum of $103,414.84. She contributes, annually, to common schools, over $750,000. In all these, and in many other acts, she has done well. We would not oppose these objects of State inquiry and State expenditure; nor decry the value of facts thus obtained. All useful information should be spread before the people. But while we approve of these matters, we are also of the opinion that there are other objects of equal and even of greater importance for investigation.

"It may be useful to know the extent, the expense, and the circumstances of poverty and crime in the State; but is it not more useful to know the causes of this poverty and crime, and how much of it arises from diseases and deaths, which might be prevented? Facts and figures may be useful to show us the sanitary condition of banks and insurance companies; but are not facts and figures more useful which show us the sanitary condition of man, who directs and controls them all, who participates in all their benefits, and whose agency ceases on the invasion of disease and death? The money of the State may be usefully expended in premiums for the best farms, the best crops, the best horses, cattle, sheep, swine, the best application of labor, and the best productions of mechanical skill; but might not something as properly be expended in teaching us how and where the best specimens of human life may be produced? what are the causes which most favorably affect its commencement, its childhood, its maturity, its decrepitude, and its extinction? in teaching the people in what places, at what seasons, and under what circumstances it is most invigorated and longest preserved? and how we can best avoid those causes and diseases, which are most likely to occur to debilitate and destroy it? It may be useful to lay out large sums of money to obtain a knowledge of the topography, the mineralogy, the botany, and the zoology,—to have described to us the character and habits of all the wild animals existing in the State; but is it not more important to have described to us the different specimens of human life, as they are modified, formed, and exist, under the various circumstances which surround them in different localities, and how those circumstances affect them for good or evil? Are beasts, birds, fish, insects, of more importance than man, who was ordained 'to have dominion over all these creatures?' The contributions of the State for public schools may properly be swelled to a sum exceeding $750,000 per annum, and thus secure the general education of the mind; but is it not more important to expend a tithe of this sum in educating the body, and in preparing healthy and vigorous abodes for the mind, that we may, as a people, become physically, as well as intellectually great? Compare it with any measure that has engaged the attention of people of this Commonwealth, or the Legislature, and few if any can be found, which have risen so high, or have equaled it in utility and importance."

All necessary expenses for this object may be easily provided for. If the different items of State expenditure, as given by the State Auditor, were examined, several may be found that seem to us unnecessary, or might be reduced so as to meet all the cost of this most important measure. It would be easy to specify such items. The Legislature cost about $1,000 per day while in session. By shortening the session three days only, enough might be saved to pay the annual expenses. As much is paid to the Bank Commissioners as would be required for the Board of Health; and it is supposed that all the advantages which result from that commission might be obtained in some other way without any expense. Other items might be specified with equal propriety, and many may be found of doubtful expediency as compared with this. Any candid mind can make his own selection. But suppose we let them all stand as they now do, the adoption of our measure would be to reduce the cost of supporting state paupers, now incurred on account of unnecessary sickness and deaths, more than sufficient to pay all expenses several times over. And if a direct tax were laid upon the people for its support, though unnecessary it would be, on the average, less than three mills to each person! Who would not consider this a very insignificant expenditure for so noble a purpose?

IV. *It should be approved because it is* EMINENTLY A PHILANTHROPIC AND CHARITABLE MEASURE.

[A discussion of the philanthropic money spent to search for a single lost navigator has been deleted here to save space. Ed.]

Yes; and we say if the money that has been thus expended,—if the lives that have been lost in trying to save one life,—had been applied to the discovery of the physical circumstances of the great mass of the people, in the application of useful remedies for their improvement, in saving their lives and in elevating their social and sanitary condition, then, instead of one life saved, the number would have been thousands.

There is another class of philanthropists who are opposed to capital punishment under any circumstances. They look with horror upon the taking of the life of a human being, which has been forfeited to law and justice, even for the crime of willful murder, though it seems necessary for the safety and protection of other lives. A great amount of labor and money is spent in the propagation of these sentiments. But now few of such persons apparently turn aside to notice the thousands of lives that are unnecessarily sacrificed,—the social murders and suicides that are daily occurring around us, on account of existing evils which might be removed! If the same zeal, labor and money were expended in diffusing correct sanitary information among the people, in removing the causes of disease which prey upon them, in propagating sound sentiments relating to life and health, and in elevating the physical, social and moral condition of man, how many more lives might be saved! In the one case, if capital punishment should be abolished, an occasional wicked life might be saved from the gallows, though the removal of the terror of instrument might lead to the loss of many more good lives by the hand of the murderer. In the other case, the philanthropist might count up the lives of thousands saved, and witness social elevation, an increase of sound morals among all classes, and a diminution of the number of murderers and other criminal offenders.

Several noble public institutions, for the removal, cure or relief of the imperfections of human organization, natural or acquired, have been established and patronized by the state. The State Lunatic Hospital has received from the State, during the nineteen years of its existence, $217,140.91, and in 1849 alone, $11,606.34. The Asylum for the Deaf and Dumb at Hartford, since 1830, has received $87,847.25, and in 1849 alone, $8,155.08. The Asylum for the Blind has received $150,773.91, and during last year, $11,500, including $2,500 for the School for Idiots. The Eye and Ear Infirmary, during the thirteen years of its existence, has received $44,000; and for the last three years, $7,000 per annum. The State Reform School, during the three years of its existence, has received $115,648 94. And the private contributions and annual payments to these institutions have probably been as great or greater than those derived from the public treasury. We would not lisp a word against these great charities, no wish they had been smaller. They are honorable to the State, and useful to their beneficiaries. It may, however, be stated that the number of recipients of these charities is comparatively few and limited. They comprehend a very small part only of the great masses of the people. And there is no doubt that the same amount of money, and even the percentage of it, which our measure might require, if applied to the careful ascertainment of the causes of insanity,—the causes of deafness and dumbness,—the causes of blindness,—the causes of juvenile depravity, and to a vigorous prosecution of the means for the mitigation and removal of these causes, as great and even greater good might be effected,—a much greater number of beneficiaries might be assisted. The diseases which these institutions are established to relieve, would be diminished and humanity would be more largely blessed.

A Humane Society has existed in Massachusetts since 1786, "for the purpose," says an early historian, "of restoring suspended animation, preserving human life, and alleviating its miseries." "Discreet and concise directions for the recovery of persons apparently dead, from drowning, strangling, suffocation, electricity, or the use of poisons; judicious rewards to such as have jeopardized their lives for the preservation of others, and furnishing convenient shelters, on our sea coast, for ship-wrecked mariners, have extensively diffused the benefits of this benevolent institution." Up to 1830, over $20,000 had been expended in promoting its objects. Medals and gratuities have been awarded to meritorious services in saving life. Similar rewards have been generously granted by the government of Great Britain for the aid afforded by American seamen to foreign seamen in distress. A very large number of other voluntary associations exist in this State; and the hand of private charity is widely opened for the cure of diseases, for relief in sickness, for the support of widows and orphans, and for various other similar objects of benevolence and charity. Too much cannot be said in praise of these noble institutions, from which flow so many streams of "oil and wine," to comfort and bless humanity; but it may be well to inquire whether there is not another and still more noble object of philanthropy.

The evils which it is the object of these institutions to relieve may be called the *diseases* of society. By them all our cities and towns suffer. The remedies lie deeper and farther back. All along we have endeavored to prove that "prevention is better than cure;" and the distinction we have made between the curative and the preventive physician, might with great propriety be applied to these institutions as the curative measures, and to others which might be adopted as the preventive measures. *These are the removal of the causes which produce the misery which these streams of benevolence are applied to alleviate*. On this deep and broad foundation lie the measures we recommend; and they should be approved as the first, the greatest, and most important objects of philanthropy and charity. If we could relieve sickness we must remove the causes of sickness, and prevent it; if we would relieve insanity, and deafness, and blindness, we must remove the causes of insanity, and deafness and blindness; if we would prevent premature deaths, and premature old age, we must remove their causes; if we would provide against widowhood and orphanage, we must remove the causes of widowhood and orphanage; and so of every other evil which it is the object of these charities to alleviate.[41]

V. *It should be approved because it is* A MORAL MEASURE.

"There is a most fatal and certain connection," says the Edinburgh Review, (Vol. XCI, for April, 1850, pp. 384, 386,) "between physical uncleanliness and moral pollution. The condition of a population becomes invariably assimilated to that of their habitations. There can be no sight more painful than that of a healthy, rosy, active countrywoman brought to one of these dwellings. For a time there is a desperate exertion to keep the place clean; several times in the forenoon is the pavement in the front of the house washed, but as often does the oozing filth creep along the stones, and she feels, at length, that her labor is in vain. The noxious exhalations infuse their poison into her system, and her energies droop. Then she becomes sick. Cleanliness becoming impossible, she gets accustomed to its absence, and gradually sinks into the ways of her neighbors. The art of concealing dirt is substituted for the habit of cleanliness; she becomes a dirty, debilitated slattern, followed by sickly, scrofulous, feverish children; and she falls through successive stages of degradation, till, physical wretchedness having done its worst, she reaches the lowest of all, that in which she has ceased to complain. The fate of the children is, if possible, more heart-breaking. All idea of sobriety, all notion of self-respect, all sense of modesty, all instinct of decency, is nipped in the bud; they congregate in masses, and mix with the worst vagrants. At last some dreadful fever forces on the notice of the public the existence of their squalid dens of misery; such as those in the Saffron Hill district,—where twenty-five people were found living in a room sixteen feet square,—where a man and his wife and four children, occupying one room, took in seven lodgers,—and where one house contained a hundred and twenty-six people, and only six or seven beds. These people save nothing, but invariably spend all they earn in drink; and with that precocious depravity too surely evinced by human beings when herded together like beasts, the young of both sexes live together from the ages of twelve and thirteen years."

"The indirect effects of sickness are far more hurtful, though less observable, than the direct effects of mortal disease. Those who merely suffer from fever are about twelve times as many as those who perish. The poison arising from animal or vegetable decomposition acts as a sedative; it lowers the tone, unstrings the nerves, and brings on physical languor and mental apathy. Persons affected by it become unfit for, and have a hatred of, labor. There is no expedient they will not seek in order to escape from toil. Under this depression, and as a relief from a peculiar inward *sinking* feeling, they have a craving for the stimulus of ardent spirits to an extent inconceivable by persons in happier circumstances; it amounts to a passion, and these debilitated beings are sometimes almost unable to control it. The same poison, by deranging and weakening the digestive organs, produces complaints of a scrofulous and consumptive character, generally accompanied by a feverish and nervous irritability, constantly urging them to the unrestrained gratification of their appetites; and so the process of degradation goes forward. The effort to struggle against the surrounding mass of filth and wretchedness, is given up in sheer hopelessness, and the man's best energies are sapped by the irresistible poison, even while he is endeavoring to resist its influence. The laborer comes home tired, and is glad to escape from the dirt and discomfort,—the poisonous atmosphere of his home,—to a pothouse. In the morning there is no refreshing meal for his support,—again he is driven to the beer-shop; overpowered by the internal craving and external temptations, he becomes a drunkard, and, in time, unequal to hard work. Soon the comforts of life are gone; then its decencies are neglected; the moral feelings, one after the other, are broken down before the most sordid appetites, alike ungovernable and insatiable: he is crushed by drunkenness, profligacy, and poverty, and sinks from one stage of vice and misery to another, till the intellectual faculties become dimmed, all moral and religious feeling expires, the domestic affections are destroyed, all regard for law or property is lost, and hope is quenched in desperate wretchedness: so that at last, owing to these withering causes, families have been found, even in

London, huddling together like animals, the very instincts of humanity obliterated, and, like the brutes, relieving every want, and gratifying every passion in the full view of the community. These are the reasons why the districts of filth are not only the districts of fever, scrofula, consumption, and cholera, but also of crime. Habits are early formed of idleness and dishonesty,—of brutality, inexpressible profligacy, and sensual indulgence; and here are educated the irreclaimable malefactors."

These are no fancied sketches, but awful realities. Such pictures of the sad moral effects of living in badly located, over-crowded, and filthy habitations, are to be seen in most of the populous cities, and, to some extent, in the country. We have had frequent occasion to enter these abodes of wretchedness. "The offensive refuse which even animals will bury out of sight, is brought into perpetual contact with human beings. It stagnates in the courts and alleys, flows into the cellars, and is sucked up into the walls. Men, women and children eat, drink and sleep, surrounded by its disgusting effluvia. The pig in its sty is not more familiar with its own odor, than is the wretched immortal in the dwelling which ignorant carelessness has built for him, and municipal and legislative indifference has suffered him to inhabit."

In some of these houses, one, two, or more families are found in one and the same room,—cooking, eating, drinking, washing, dressing, undressing, sleeping, and doing many other acts namable and nameless. Fathers and mothers, men and women, boys and girls, may be seen living and sleeping in promiscuous confusion. In some instances, too, persons may be found in the immediate presence, or in the same bed, with a dead body, struck down with typhus, cholera, or some other zymotic disease; or by the slow wasting of consumption; and in others, a child is born, or an adult dies,—one immortal spirit makes its entrance into, and another makes its exit from, this world, at nearly the same time, in the same wretched abode, and surrounded by similar appalling circumstances. Can moral principle be inculcated in such an atmosphere, and surrounded by such influences? Must not degradation, vice, crime, be their natural, inevitable tendency? If they are not, in individual instances, they must be taken as rare exceptions. "You can not degrade the physical man by a life-long familiarity with scenes of filth and indecency, without debasing his whole moral nature."[42]

The object of the measures we recommend is to remove filth and prevent disease, to introduce those accommodations which allow, and reform those habits which prevent, the elevation of the physical man, the social nature and moral condition of fellow-beings. They are the best handmaids we can give to prosperity, to morality, and to religion.

[A long quotation from John Simon has been removed to save space. Ed.]

VI. *It should be approved because the* PROGRESS OF THE AGE DEMANDS IT.

The half century just now drawing to a close, is a wonderful period in the world's history. Inquiry and discovery have been abroad in the earth. New facts and new truths been ascertained—new sciences have been developed, and boundaries of old ones have been greatly enlarged. These discoveries have produced revolution after revolution,—have multiplied the means of convenience, comfort, luxury,—until our social and practical life is a very different thing from the social and practical life that existed ago. And were it not that we have grown up with the results, they would appear almost beyond the limits of reality or possibility.

[Discussions of progress in the fields of transportation, electricity, and chemistry have been deleted to save space. Ed.]

Do not these characteristics of the age demand that something should be done for Sanitary Reform? Shall preserving our lives, and of invigorating our health, be the only art that shall remain in the same stationary position which it has long existed; or that shall be permitted sometimes to make a retrograde movement? Shall ignorance, presumption and apathy brood over this most vitally important matter, while intelligence, attentive application, and activity press forward other objects in their rapid career of advancement towards perfection? We have described the field of inquiry,—we have shown that there is encouragement to labor; and we believe that in no science or art,—in no department of knowledge or discovery, can more important or more useful achievements be made. Vaccination, etherization, other preventive agencies, are great discoveries, but not greater than other and similar ones which are destined hereafter to be known.

Observation and discovery in the cure and expulsion of disease after its invasion we would not exclude, but would advocate and elicit in every available and useful form; and we believe there is much in this department of knowledge yet to notwithstanding the great progress which medical science has made within the past few years. One of our most intelligent and eminent physicians was lately asked—"Do you suppose that the medical edge which shall admit the belief that further useful discoveries cannot be made in the modes of treating disease?" "Certainly not," said he; *"we are as yet only on the borders of ignorance!"* This may be true in many respects. Notwithstanding the brilliant discoveries that have been made in physiology and in the various departments of medical science and medical practice,—notwithstanding the more thorough education and the more eminent medical skill that characterizes many physicians of the present day,—there are few of them who have not sometimes discovered the imperfection of human attainments, and the uncertainty that may yet attend a practice guided by the highest medical skill. The measure we recommend is designed to pile up fact upon fact, in relation to life, disease, and mortality, until their nature and laws are ascertained and demonstrated ; and thus aid, in various ways: in increasing knowledge, in leading to important discoveries, and in removing those uncertainties which attend the practice and success of the profession. And in this way we shall attempt to meet the demands of the age.

But the Sanitary Reform we advocate lies chiefly in another field of observation and discovery, which has as yet been very imperfectly explored. This may be called the *Province of Prevention*—prevention of disease—prevention of suffering—prevention of sanitary evils of every kind; and the efforts of those who enter this hopeful province should be directed to the discovery and the means of removal of the causes of these evils. Every effect must have a cause—every disease has its cause. And the effort should be to ascertain the exact relation which one bears to the other—what known, exact and positive causes, will produce a known, exact and positive disease, or a sanitary evil of any specific kind, and none other. And is not this as far within the limits of possibility and certainty as is the treatment and eradication of disease? Cannot the exact nature of an atmospheric, local or personal cause of disease, and the exact personal condition with which it most easily assimilates, and which it most easily affects, be definitely and accurately ascertained? If such a desirable discovery could be made, what manifold blessings on humanity would it confer! We know that a human body, unaltered from its original organization or functions, coming in contact with the virus of small-pox, either inhaled while floating in the atmosphere, or imbibed by outward contact or inoculation, will produce a specific effect,—a specific disease. Here is cause and effect of a known and exact relation to each other. We know, too, that vaccination, properly performed, will alter the original organization or functions, so that the same virus will not in either way take effect. Here is another exact cause and effect whose relations are equally known. This is a discovery which has, within the last fifty years, saved thousands and thousands of lives, and might have saved thousands more, had it been universally applied. Now it is but fulfilling the demands of the age to press inquiries vigorously, and to endeavor to discover the causes of every disease which may attack the human body. If the same exact and definite information could be obtained, as to the causes of cholera, dysentery, scarlatina, typhus, consumption, and the other grave diseases, to which we are subject, and as to the particular condition of the individual which they most easily affect, how much might be done for the avoidance of those diseases by the removal of their causes! How many lives might be saved, how much suffering might be prevented! Does not the spirit of the age then demand the approval of a measure which promises to do this great,—most important work?[43]

VII. *It should be approved because* IT INVOLVES AN IMPORTANT DUTY.

If a measure is practical, useful, economical, philanthropic, moral, and demanded by the spirit of the age, it needs no argument to show that it is our duty to approve it. And if such is our obligation, nothing further need be said. For, in our judgment, whoever violates a *known duty* is guilty of crime, and justly makes himself liable to its penalties. If an individual swallows poison, and death immediately follows; or if, by improper eating, drinking, or course of life, he gradually debilitates his constitution, and death is the ultimate consequence, he violates a known law, neglects his duty, and justly suffers the physical penalties of his guilt. If we, as social beings, make no effort to elevate the sanitary condition of those around us by removing the causes of disease, we violate a known duty, and make ourselves justly guilty and liable to punishment; and we shall inevitably be punished, either by suffering sickness, or by death, or in some other way. If a municipal or state authority neglects to make and execute those sanitary laws and regulations on which the health and life of the people depend, they violate a known duty, and are justly chargeable with guilt and its consequences; and they will certainly be punished, either by means of less capacity for labor, of increased expenditures, of diminished wealth, of more abject poverty and atrocious crime, or of more extended sickness and a greater number of deaths; or in some other form. These are the physical and social consequences of a neglect of sanitary duty. But there are others; and we would mention them with all that regard which is their due.

It has already been said that the first sanitary laws were the direct revelation of the Divine Lawgiver; and that they have been further developed in the successive ages of the world. These laws are now, to some extent, well understood. And may we not conclude that we shall be brought to an account for the manner in which we have observed and obeyed them? May we not reasonably believe that we shall hereafter see the wisdom of that providence which produces the earlier and later deaths, the physical sufferings, and the innumerable sanitary evils which surround and afflict us in this world,—that they were the just and inevitable result of violations of those sanitary laws which were given us for our guidance and happiness,—and that these evils might have been avoided if these laws had been understood and obeyed? May it not then appear that many a lawmaker, many a public administrator, and many a private individual, has been guilty of robbing others, and of robbing himself, of health and of life,—all that is dear on earth;—guilty of murders and of suicides;—and none the less fearfully real and punishable because they were unintended? The possibility of such a result may well arrest universal attention. "In regard to the whole range of the laws of health and life, Providence seems to treat mere ignorance as an offense, and to punish it accordingly." There is a great social personal responsibility resting upon everyone in this matter; and it is well that it should be felt in all its force and that all the duties which it requires should at all and in all places, be wisely discharged.

VIII. *It should not be* DISAPPROVED *because* OBJECTIONS MAY BE BROUGHT AGAINST IT.

In the previous pages we have anticipated answers to some of the objections that may be brought against this measure. There are some others, however, which require to be noticed.

1. *It may be said,*—"Your plan is too complicated; you require too much; it will not and cannot be carried into operation."

Before characterizing any measure, a candid mind will at least examine, and endeavor to understand it. There are some persons, however, who, even without previous study or knowledge, and by a more casual glance, deem to give an intelligent opinion whether a measure demerit. Sometimes a plan may appear complicated before examination, but simple afterwards. It has been the fate of new measures, generally, to be thus hastily judged. It was so in the first stages of the sanitary movement in England; and it is not supposed that our recommendations will be exceptions to the general rule. Various reasons and motives operate upon the minds of men to lead them to different conclusions. Ignorance, prejudice, interest, or some other cause, may do it. We well recollect the remark of an intelligent and distinguished member of the Legislature, now deceased, when the application for an act of incorporation for building a railroad between Boston and Worcester was under consideration, and his influence was solicited in its favor:—"I have no objection," said he, "to the passage of the act, for the road will never be built;—it is impracticable. And if it could be built, it would be perfect folly to do it,—it could not be supported." He did not live twenty years afterwards to see $5,000,000 expended on the road, and 57 trains pass over it daily; a single passenger train sometimes carrying 2,700 persons, and a freight train carrying 400 tons of merchandise! The plan for taking the census of Boston, in 1845, was opposed by some, at its first introduction, because it was alleged to be impracticable and useless. The result, however, proved it otherwise in both respects; and the same plan, substantially, has since been approved and followed in other cities, and has this year been adopted for taking the seventh census of the United States. It was said that the laws for the registration of births, marriages and deaths could not be carried into operation; and no special attempt was made to do it in Boston until 1849, when, by a simple ordinance, it was successfully done. Similar illustrations might be furnished in the history of the incipient stages of nearly all new measures and enterprises; but after they have been put into operation, they have been found so practical and so useful that it has been thought strange that they were opposed, and that the same thing had not been thought of before! And in this light, we have no doubt, this measure will soon be viewed.

2. *It may be said*,—"The measure is not applicable to this State; it may be well enough in some other places and countries, but we do not suffer evils which require such remedies for their removal; no people are more healthy than we; we are well enough as we are."

"We most cheerfully and most gratefully admit that in some of our towns, and among some classes of our people, sanitary evils do not exist to so great an extent as in some other places. But while we admit this, we affirm, from the most authentic evidence, that in many places and among many classes of our population,—in many families and among many persons,—there is scarcely to be found, anywhere, more ignorance of the laws of health, more disregard to proper sanitary regulations, and more suffering for their neglect. Our towns, our cities, and our dwelling-houses, it is true, are not so old, nor do many of them have so forbidding an exterior, as many in Europe; but it does not take ages to convert a new house,—a palace,—into a den of filth and disease. Conditions may exist, and do actually exist, on open fields, on hill sides, in the interior of the country, as well as in cities, favorable to the production of disease. A whited sepulchre may be full of dead men's bones (or causes that will produce them) and all uncleanness. Those who say that, in this State, the measure is inapplicable, have yet to learn the condition of the people and furnish themselves argument for its necessity.

How stand the facts? The average number of persons to a dwelling-house in London, in 1841, was 7.5; in Liverpool, 6.9; in Manchester, 5.7; in Edinburgh, 6; and in the whole of England, 5.4. And it has been said that, in some of the districts in the city of London, sixty persons are to be found in one house. The number of persons to a dwelling-house in Boston, in 1845, was 10.75; and, section of the city containing 3,131 inhabitants, the number to each house was 37; and the space for each inhabitant, in the whole district, including streets, was equal only to seven yards! This is equal to some of the worst districts in Liverpool. One of this commission predicted, years ago, that if the cholera or any other epidemic should appear in Boston, it would first take up its abode in such places. We refer to from the valuable report of the City Physician, in the appendix, for evidence of the fulfillment of this prediction. And it must be recollected that, in these places, typhus, scarlatina, dysentery, and other epidemic diseases, are doing daily what cholera does only occasionally. In these abodes "infancy is made stinted, ugly, and full of pains,—maturity made old,—and old age imbecile; and pauperism made hopeless every day."

Much has been said of the sanitary evils of London,[44] where 32 per cent. of the deaths are those of persons under 5 years of age, where the average age of all, at death, is 26½ years, and where the annual rate of mortality for the whole population is 1 in 40. In Boston, from 1840 to 1845, 46.62 per cent. of all the deaths were those of persons under 5 years of age, and in some classes of the population more than 62 per cent. were under that age; the average age of all that died in the same period was 21.43 years, and of the catholic burials, 13.43 years only. And the rate of mortality for the whole population, for the last 9 years, was 1 in 39, and for the last year, 1 in 26. *And yet Boston is a "healthy place!"* London, with its imperfect supply of water[45]—its narrow, crowded streets,—its foul cesspools,—its hopeless pauperism,—its crowded grave-yards,—and its other monstrous sanitary evils, is as healthy a city as Boston, and in some respects more so. If sanitary reform is needed in one, it is needed in the other also. And many of the country towns suffer a mortality nearly as appalling,—and yet "this measure is not applicable to us!"

There is another consideration shewing the applicability of this measure. Under no government is human life more valuable than with us; and under none is it more important that it should be preserved and invigorated. If it is for the well being of society in Europe that human life should be preserved,—if it is considered a high social and moral duty to elevate it from a low to a high standard of health, where the poor houses are crowded with inmates,—where labor is cheap, and where its products add so little to general or to individual wealth, how much more is it for the well being of society in this country to preserve human life, where labor is in so great demand, and where each laborer, so long as he continues in health, not only contributes to the general wealth, but provides for his own individual independence! If sanitary reform is a duty there, where the life of man is, in a pecuniary view, of so little value, how much more is it duty here where it is of so great! And in a social and moral view the contrast makes the obligation still more binding.

Another view of the subject may be presented in this connection. Whatever may have been the sanitary condition of the people of Europe, some of the most unfavorable specimens have emigrated to this country, bringing with them and imitating the customs in which they were educated in the land of their nativity. By these means many of the evils which have there called so loudly for reform have introduced among us. Such evils cannot be safely endured in this State. It is in vain for us to suppose that they can be confined to the persons alone whom they immediately affect. We cannot wall up the pestilence, or shield ourselves from its influence. It will diffuse itself through the whole until all classes, to a greater or less extent, feel its power,—until all persons and all interests, in all parts of the State, are affected. We have shown that the public health is deteriorating,—that human life, on the average, has been gradually growing shorter; and it may perhaps be partly owing to this cause. And if we would arrest the downward tendency, we must adopt, and carry forward an efficient plan of sanitary reform. All the arguments in its favor apply with tenfold more force here than in foreign countries. Can anyone say with truth, in this view of the subject, that the measure is not applicable to us? We need such a measure to elevate the sanitary and social condition of every part of the population.

We have said that great ignorance of the laws of a reckless disregard for their requirements, prevail among a large portion of our native population. And this is emphatically true; although as a people we may be generally educated,—possess great application and industry,—great energy perseverance, yet at the same time we are sometimes led recklessly on by desires for wealth, for self-gratification, in total ignorance of correct sanitary laws, or in total disregard of the duties of preserving our own lives and the lives of others. These dangerous sanitary habits should be discarded, and more safe and correct ones substituted in their places. And in no class of our people, among few or no individuals, does there exist a state of health so high that no higher can be attained. By a clearer knowledge of the physical laws, and a closer application of those laws to habits, regimen and training, to local and atmospheric influences, a much higher vigor, a greater power of endurance, and a more full enjoyment of life may be attained by every class of the people. And will not this measure greatly aid in the accomplishment of this most desirable reform? Is it not applicable to us,—*to any people?*

3. *It may be said,*—"I don't think much of your statistics; you can prove anything by figures."

This is an oft-repeated remark, but in our judgment may be easily answered. *Statistics* may be defined as the *science or art of applying facts to the elucidation and demonstration of truth*. It is the basis of social and political economy, and the only sure ground on which the truth or falsehood of theories can be brought to the test. Mere columns of figures may or may not be statistics. They form, in any case, a small part only of the illustration. Combination and deduction are required to give them full effect. We belong to that class of statists, who have no particular fondness for figures, though we have a great fondness for facts. We use figures as the representatives of facts, not fiction,—of truth, not falsehood,—and find them very convenient for that purpose. We find it very difficult to prove or disprove many propositions without them. We are aware that some persons have a great antipathy to facts and statistics; but in this "matter-of-fact-age," they are required; and they are far more useful and important than the fiction and theory, the assumption and assertion, that have occupied so much of public attention. We would follow, in estimating human life and human health, in all their various departments, bearings and relations, the same course that judicious men pursue in other matters.

The state and condition, the statistics of a country, can be known only by gathering together the facts as to its movements and progress; and the statesman looks at the figures which represent these facts, and combines and deduces the truths they contain, for his guidance.

It is a fact that at an election Mr. A. received a certain number of votes, and Mr. B. a certain other number, in each several towns. These facts, or statistics, being gathered together and represented by columns of figures, prove that Mr. A. received more votes than Mr. B., and is therefore elected. Suppose you attempt to prove by these figures that Mr. B. was elected, what process would you adopt?

It is not often that the judicious merchant or other man guesses, estimates, or theorises on this or that kind of business,—on this or that man's account,—on his own profit and loss,—or on his own pecuniary sanitary condition; but he goes to the statistics of his business,—the records of his progress—his books; and he values and is guided by the definite facts thus disclosed. So we prefer a definite fact, even if it appear as a statistical truth, and represented by figures, to uncertain theory or vague speculation and assumption.

It would be easy to illustrate, almost indefinitely, these general remarks, and to show the advantage and absolute necessity of this mode of presenting truth, but we deem it unnecessary.

4. *It may be said*—"This measure will interfere with private matters. If a child is born, if a marriage takes place, or if a person dies, in my house, it is my own affair; what business is it to the public? If the person die at one age or another,—if he die of one disease or of another, contagious or not contagious, it's my business, not another's,—these are private matters."

Men who object and reason in this manner have very inadequate conceptions of the obligations they owe to themselves or to others. No family,—no person liveth to himself alone. Every person has a direct or indirect interest in person. We are social beings—bound together by indissoluble ties. Every birth, every marriage, and every death which, takes place, has an influence somewhere; it may not be upon you or me now; but it has upon some others, and may hereafter have upon us. In the revolutions of human life it is impossible to foretell which shall prosper, this or that,—whether I shall be a pauper or have to contribute to support my neighbor, as a pauper,—whether I shall inherit his property or he inherit mine; and every person should be willing, and even desirous, to place within the reach of every other person, the fact that he has existed, and the means of identification. This is the common right which the public should claim of everyone, and the common privilege which everyone should have in all others.

"A well-organized system of civil registration," says the Edinburgh Review, (Vol. XCII, for July, 1850, p. 43) "is one of the first wants of an enlightened people. No man in such a people is above or beneath the obligation of authenticating his existence, his claims on the protection of his country, and his fulfillment of the duties of a citizen,—or of contributing his individual quota of information, in what personally concerns himself or his family, in reply to any system of queries which the government in its wisdom may see fit to institute respecting them. Such information may be regarded as a poll tax, which, in this form, a government is fairly entitled to impose, which is at once the justest and least onerous of taxes; or rather it may be looked on as a mode of self-representation, by which each individual takes a part in directing the views of the legislature in objects of universal concern. Nothing, therefore, can be more unreasonable than to exclaim against it, or to endeavor to thwart the views of government in establishing such a system,—nor anything more just than to guarantee its fidelity by penalties imposed on false returns or willful omissions."

Erroneous ideas on this subject have, to some extent, existed in the minds of many persons. It has been thought that it was indelicate and impertinent to be thus inquisitive; but happily these views are fast passing away. It is becoming more and more apparent that such information is useful to the public, to protect public rights and public health, and may be very important to the individual, to protect personal rights and personal health. And a little candid thought must convince every unprejudiced mind, that immense benefit would result to the whole community and to each member of it, by the adoption of this measure, and by the information which it would elicit. A knowledge of these matters, alleged to be private, may be an incalculable public benefit. Without it, any attempt to estimate the sanitary condition of a place or a people, and the prevalence of different diseases, will be nearly worthless. The results will be uncertain, and not reliable as a correct basis on which to found remedies for improvement and progress.

5. *It may be said,*—"This measure will interfere with private rights. If I own an estate haven't I a right to do as I please? to build upon it any kind of house, or to occupy it in any way, without the public interference? Haven't I a right to create or continue a nuisance—to allow disease of any on my own premises, without accountability to others?"

Different men reason differently, in justification of selves, on this matter. One man owns real estate in an healthy locality; and if its condition were known, it might affect its value. Another has a dwelling house unfit residence of human beings; and he will oppose any efforts to improve it because it will cost money, and he can in its present condition. Another does business in a place where, and at a time when, an epidemic prevails; and occupation may tend to increase it; and, if these facts were known, it might affect his profits. These and similar may lead different minds to oppose this measure. How extensively such opinions prevail we will not attempt to state. Some twelve years since one of this commission introduced, into the city council of Boston, an order of inquiry relating to a certain locality supposed to be unhealthy; but it was strongly opposed, because, as was stated, it would impair the real estate in the neighborhood! There may be individuals who place dollars and cents, even in small amounts, by the side of human health and human life, in their estimate of value, and strike a balance in favor of the former; but it is to be hoped that the number of such persons is not large.

We subjoin extracts from three different authorities, which contain correct views on this subject:—

"Every man who chooses to hold property in a town must learn that there are certain duties connected with that property by the very nature of it, which must be fulfilled. He cannot use it as he would. He must, on the contrary, submit to those wise legislative measures which in all ages have been found necessary to protect the common weal. The attempt to obtain exorbitant profit, either from the sale of land or the rent of houses, must be curbed by a proper public spirit, and by the legislature declaring what kind of streets and houses it will allow to be built, and how many upon a given space. We must revert to the ancient laws, and permit nothing to be done, come what may, which shall injure the health or comfort of the inhabitants. But those who possess property must not imagine that in doing this we shall interfere with their real interests; for in the moral arrangements of the universe there are certain checks which infallibly prevent our doing as we would in these matters. We may build double the number of houses, and quadruple the population on any given space, but sickness and death, and moral as well as physical degradation, will step in and prevent our reaping the fruits we anticipate."[46]

"One of the primary prejudices,—one of those least spoken of but most felt,—which sanitary reform has to encounter, is a vague apprehension of undue interference. All regulations for securing cleanliness and removing filth, are apt to be considered as invasions of the privacy of the domestic hearth and the person, and amounting to an impertinent intermeddling, in matters concerning which it is insulting even to be inquisitive. But in reality the object of sanitary reform is to free the citizen from the vile fetters with which the acts of others have actually bound him, and to leave him free to pursue the natural tendency towards civilization and refinement, rather than to assume any arbitrary control over his actions. We believe it to be quite true that it always injures the individual to do for him what he ought, and is able, to do for himself. But the operative workman must live in the city, or starve; and if selfish wealth has made the city such that he cannot find a cell in it which is not a living tomb, saturated with corruption,—then he is not left to the freedom of his own actions, but is subject to an abominable bondage caused by the conduct of others. The strength and skill of Hercules could not enable the city artisan of Glasgow to live in purity; and if legislation cleanses the Augean stable, it is not doing for him what he should have been left to do for himself, but only saving him from suffering by the selfishness of third parties beyond his reach."[47]

"In the restrictions which prevent every man from his own profit or gratification that which inflicts on neighbor a deadly injury, there is no hardship;—it is simple justice. Our law requires that the railway company, the master of steamboat, and the manufacturer of gunpowder, should respectively conduct their operations so as not to endanger the safety of the community; and there can be no reason why the same responsibility should not be attached to those whose profitable occupation is building or spinning. Such intervention on behalf of the public is not to be confounded with the old sumptuary laws,—for it interferes with things, not with persons; nor can it be compared to attempts to regulate labor and wages, or to restraints on trade,—for it is not done to procure, artificial adjustment of something which men can best for themselves, some speculative advantage, but, on the principle of *salus populi suprema lex*, to protect one set of human beings from being the victims of disease and death through the selfish cupidity of others. The owner of the soil is the person who mainly profits by the accumulation of a city—this, at all events, are advantages for which he neither toils nor spins; and many of the princely fortunes of our day have been created by the rapid rise,—often so far as the owner himself may know, of city populations. It does not seem then to be a very hard rule either of morality or law, that a proprietor who accumulates wealth by means, shall be compelled to submit to regulations which, should they even in some degree reduce the amount of his gains, may be a security, against the lives of those who by the necessities of their position are enriching him, from being sacrificed to his avarice or his recklessness. While he derives a profit by letting out his square yards of the earth's surface, it surely is not unfair that he should become bound not to it to the occupant perforated throughout with pitfalls in which health and life may be lost."[48]

"It is the common right of the neighborhood," says Dr. Simon, "to breathe an uncontaminated atmosphere; and with this common right nuisances must be considered to clash. It might be all infraction of personal liberty to interfere with a proprietor's right to make offensive smells within the limits of his own tenement, and for his own separate inhalation; but surely it is a still greater infraction of personal liberty, when the proprietor, entitled as he is to but a joint use of an atmosphere which is the common property of his neighborhood, assumes what is equivalent to a sole possession of it, and claims the right of diffusing through it some evanescent effluvium which others, equally with himself, are thus obliged to inhale."

Such are the opinions of some of the most eminent authorities in England on this matter; and they are sanctioned by the highest judicial tribunal in our own State. There have been few decisions in our courts, in cases for violations of the sanitary laws of the Commonwealth; but such as have been made are in opposition to the principle of this objection, and in accordance with the views here presented.[49]

6. *It may be said*,—"Your measure will create an unnecessary expense; the State already spends too much money; we cannot afford it."

Everyone should reflect that this is not an expense, but an investment,—a saving,—a "stitch in time," which is designed to add to the wealth and not to the poverty of the Commonwealth; and such we have proved will be the result. Expenditures for celebrations, and for various temporary or other purposes, and of doubtful expediency, more than sufficient for this purpose, are often made within this State, without opposition and without counting the cost; and why should the trifling outlay for this most' useful measure be urged to defeat it? But we have already demonstrated the economy of the measure (especially in pages 250 to 260) and we deem it useless to reply further to such as may still persist in this making.

7. *It may be said*,—"If you diffuse information on matters generally among the people, will you not make every person his own physician? will you not increase, and press quackery; and thus magnify and not diminish the sanitary evils which it is your purpose to prevent?"

It seems to us that this measure will have an effect opposite to the one here supposed. It is not intended, in the least degree, to usurp or to interfere with the duties of the physician, in the cure of disease, but to aid him in his efforts, and to dignify the importance of those efforts. It is, however, intended to teach the people so much of their physical organization, and so much of the influences that act upon them, that they may know, and be led to avoid, the *causes of disease*, and thus escape the infirmities, the sufferings, and the consequences of sickness. This measure will teach to obtain proper medical advice when they are sick, and not to tamper with themselves or with their diseases, by unsuitable or dangerous remedies, nostrums or drugs, ignorant of their applicability to their own particular cases. It will lead them to understand when or in what stage of the disease, it is best to obtain professional advice; from whom to obtain it; and to discriminate between the good and the bad. Ignorance permits a cause of disease to operate unchecked until the disease itself actually invades the system; and the same ignorance permits the disease to make such advances before advice is obtained, that it is often impossible to arrest it. Intelligence, on the other hand, understands and avoids the causes of disease; or if disease should happen to have made its attack, the same intelligence will require medical advice of the kind at the commencement of the disease, when advice is most useful, and when the power of medical remedies is most decisive. And this intelligence will preside over all the management of the sick room; and thus second all the efforts of the medical adviser, and give all possible effect to the remedies used for the expulsion of the disease. Ignorance and assumption constitute the essence of quackery; intelligence and a desire to do right, contemn it; and this measure is designed to prevent the former, and promote the latter.

8. *It may be said*,—"If you say so much about health and disease you will excite the alarm of the people, and create more disease than you prevent. It is better to let a place that is unhealthy remain so, unimproved, than to alarm the people about it."

If a place is unhealthy, and on that account an improper place of residence, does not a feeling of common humanity require that it should be known? If people are on the brink of a dangerous precipice, shall they not be told of their danger?—shall they be permitted to pursue their course to destruction, for fear of exciting their alarm? Is not a knowledge of their condition their only safety? The objection, in our judgment, instead of being a reason for the rejection of this measure, is a powerful one for its approval. "To be forewarned is to be forearmed." It is only those who know their capabilities and their liabilities,—who know their dangers and means of removal or escape, that are confident and unalarmed. The ignorant, unconscious of the means of mitigation, are more likely to be timid, alarmed, and to be overpowered with groundless fears, on the approach of danger.

Suppose that it should be ascertained, after careful and particular investigation, that a certain locality in the State is unhealthy,—that in that place certain influences exist, and certain diseases prevail, that destroy, unnecessarily, a great amount of life, and produce a great amount of physical debility, and incapacity for labor. What is duty in such a case? To permit the evil to remain unexposed, and the destruction of life and happiness to continue unchecked? or to make known to the people the exact circumstances in which they are placed, the causes of the sanitary evils which they suffer, and the means of removal? Would not this knowledge lead them to adopt those precautionary means which would reduce the amount of the evil, as their only safety? or, if this were impossible, induce them to seek some other place of abode? and under such circumstances would not such a removal be a duty? Self-preservation on their part, and philanthropy on ours, say so; and so in our judgment this objection is removed and rendered powerless.

9. *It may be said*,—"It will interfere with Divine Providence."—"It was to be so."—"It was so ordered."—"If we are to die of cholera, typhus, consumption, or any other disease, it must be so,—it is useless and improper for us to interfere."

This is an old sentiment. It has formed a part of religious belief in different nations, from remote antiquity to the present time. Death, whether it come in the shape of a plague, mowing down its thousands, or as a solitary messenger, slowly wasting or suddenly destroying the individual, has been considered by many as the special Providence of God, with which we ought not and cannot interfere. As late as 1720, when inoculation for the small-pox, as a protection against the disease in the natural way, was introduced into Boston, it was strongly opposed; and one reason given was, that it would interfere with this Providence. And even in our day some consider it a disobedience to a Divine command,—"in sorrow thou shall bring forth,"—to inhale ether or any other agent to mitigate pain, or to alter the character of labor!

We shall not attempt a discussion of any theological or philosophical question, relating to the providential agency manifested by the Supreme Governor of all things, in presiding over and governing the universe which he has made; but we would view this great matter of life and health in the same light that "we view all other matters with which they are connected, and over which this providential agency is extended. We see clearly the operation of cause and effect, we should see wise laws wisely administered in every event that takes place in the universe. The husbandman does not sit down by the side of his field, and wait until the time of the harvest; and if he does not receive a crop, when he did not sow his seed; or if he did sow, when he neglects the proper care of the growing plant to protect it from injury,—from weeds, noxious agents, or "filth" of any kind,—say "it was to be so." His agency, his care, his labor, is necessary to success. So in almost every event of practical life, we act in direct opposition to the very sentiment of this objection. If "it was to be so" is to be written upon every effect, why do we send for a physician when we are sick? Why do we take food to preserve life, or use means to cure disease? Why do we not let causes take care of themselves? Everyone, in applying the objection to practical life, must see its fallacy. We believe that "God helps those who help themselves," and none others. It was a maxim of Dr. Chalmers, that "man should trust in God as if God did all, and labor themselves as if man did all."

Pain, suffering, and the various physical evils to which we are exposed, may not seem to be a necessary part of the scheme of nature, but only as incidental to it. They result from the violations of her laws; and are permitted for wise purposes, perhaps for the discipline and development of our physical and moral powers. In the operation of epidemic diseases some innocent may suffer; but they are individual exceptions to the general role; and they come like drought or blight upon the labors of the honest husbandman. It is easy to perceive that the sources of many, even a vast majority of these evils, may be removed by those who suffer from them; and that they do not lie so deep that human agency cannot discover and destroy them. Man has a power to wield over and to expel disease. It has been asserted, by high authority, that "it would be possible to banish nearly all disease from the earth, and to restore man to his pristine vigor. If such a belief be true, that afflicting contrast between the sufferings of mankind, and the beauty and beneficent ordering of the universe, disappears. The source of the contrast is found to be within us,—the fountain of the evil is in: ourselves. We are our own tormentors, and are not merely the prey and unresisting victims of powers higher than ourselves."[50]

10. *It may be said,*—"We acknowledge that all you say is reasonable and cannot well be gainsayed; but we are a business-like, a money-making, and money-loving people. We are too much occupied to consider these matters. So many other things take up our attention that we haven't time to examine, much less to carry out your measure; our people are not up to it yet."

We are fully aware of the prevailing tendencies of the public mind, and of the indifference and apathy with which subjects relating to health are generally regarded. It is times when epidemic diseases prevail, or when we are reminded of their effects by our own sufferings or losses, we are excited and interested. We are too much inclined to consider health as a matter "belonging to the doctors and not to us," and to depend upon them for a supply; that money is best obtained and time is best employed, when the dollar is sought, and desire is gratified, without regard to the sanitary consequences of any particular mode of doing it. Some strange anomalies and inconsistencies are found in society as at present constituted.

"*Money-loving!*" And is this the only object of life? Are there none that overlie it? And even if it be uppermost, are we pursuing the best means to obtain it? It is true that most of us, when selecting an occupation, a place of business, a place of residence, do not inquire into its sanitary influences, as we should do if we acted wisely: if it promises money we enter into it generally with characteristic zeal, regardless of the consequences. But how often do we have to learn that we committed an error! Instead of gradually accumulating capital, while preserving and invigorating our health: in a way which would give us a more prosperous, a happier and longer life, we make a hazardous speculation and lose the whole. This is the result of ignorance. It is worse than that. It is folly and crime thus to rush recklessly into a sea of uncertainty, when safety and competence are certainly attainable otherwise. Our thoughts receive a significant illustration in an extract of a recent letter from California. "Our party," says this writer, "four months ago, consisted of six persons, of whom two only are now alive. Two died of a disease occasioned by over-exertion and improper exposure at the diggings, on the El Dorado; one of a violent fever, occurring after a scene of frolicking and dissipation in the village; and another was murdered and robbed in his lodgings, of the few thousands of gold dust, which he had gathered by hard labor, and was about to carry back to his native New England. We, who are alive, are doing tolerably well, but work at great risk of property, health and life." If these six persons had known exactly their sanitary capability and liability, and what to do and how to do it, they might have preserved their lives. They might have wrought and acted so as to have avoided the causes of disease; or, if this had been impossible, they might have had discretion enough to abandon their suicidal residence or employment. We would not discourage, but encourage, energy and perseverance in every calling, but only in subordination to higher obligations, and in strict regard to the higher duties of self-preservation and self-invigoration.

"We hav'n't time!" Indeed! but we have time for other things,—for labor, for leisure, for dissipation, for almost anything we desire to pursue. And to what purpose more useful than the preservation of our lives and health can we devote a portion of our time? If time is not taken by us, and used by us, for this object, it will be taken by another agent; and we shall be prematurely deprived of an opportunity of using it ourselves for any purpose whatever. A shortened life and a debilitated frame, will be the consequence of ignorance inattention; a lengthened life and an invigorated constitution, of knowledge and application. In plain English, *we have no time* means *we have no* DISPOSITION. If we have to examine and carry out this measure we shall find time and ability to do it, and still have enough for other purposes. "Where there is a will there is a way;" where there is a disposition there is a time,—"a time for all things."

The younger portion of society may be taught the lessons of experience which the elder portions have learned during a long life,—the physical calamities to which they have been exposed, the mistakes they have made, and the remedies reparation they have used. They may be told the best course to pursue to invigorate and prolong their own existence. But how few apply this instruction as a guide to their own in physical improvement! How great a proportion say, "it will do well enough for old people to talk so, but we are enough as we are, we live in another age;" and they neglect and refuse to apply the useful instruction of others and wait until taught by their own sad experience. They are then often too old to profit by it. They did not learn how to live, until their life-time had nearly expired.

Our people spend an indefinite amount of money in the purchase, and of time in the perusal, of the miscellaneous literature of the age; but a book, written with ever so much talent and authenticity, which contains facts relating to the in-comings and out-goings of human existence, and to the rise and fall in the tide of human welfare,—matters which concern and affect every member of society,—is too dry and statistical; it will not interest; "we haven't time to examine it!" An individual can announce that he sells a patent medicine, which is alleged to be a cure for all diseases, and even those supposed to be incurable; and, by a systematic puffing, he will command the public ear and amass a fortune by drafts upon public credulity; but the man who announces, in plain and simple terms, a wise and truthful plan for avoiding disease, for living without sickness and without medicines, will be regarded with indifference, and informed that "the people are not up to it yet." A lecturer can announce a new system of medicine, "electro-biological" or otherwise, and attract crowds of attentive listeners, night after night; but if an earnest, thoughtful, honest man, presents the simple, everyday, unvarnished principles, by which disease may be avoided and the causes of disease removed, and the facts by which these principles are demonstrated, he will find few listeners, and even those whom he is fortunate enough to obtain, may pronounce him unworthy of confidence,—a visionary dreamer.

The upsetting of a pleasure-boat, drowning several persons; a shipwreck, consigning human life to a watery grave; the bursting of a steam boiler, scalding and scattering those within its reach; a collision on a railroad, mangling or destroying the passengers; a fire, murder, suicide, or other sudden and sad calamity, will sometimes occur and produce a general public excitement. All the facts are gathered together and minutely detailed in the newspapers; people collect in the streets, and in public and private coteries, to talk the matter over; a strong sympathy is manifested for the sufferers; judgment is immediately pronounced upon the guilty; and a loud call is made for such a punishment as shall be a warning against a repetition of the offence. But the dark stream of disease and death, is every day and every hour crowded with victims, carried down upon its ever flowing current beyond the limits of time, and all are unmoved and without emotion or excitement. The people "have'n't time to consider it;" and make no attempt to arrest or lessen the amount of disease and death that constantly float, in their onward course, on these dark waters. They never ask the question, Can this mortal current be stayed, the number of these victims lessened, the amount of this human wretchedness and human woe mitigated or prevented? And even when informed, in a demonstration as clear as meridian light, *that it may be done*, they make no effort to do it, and reply, "We are not up to it yet; you are before your time; you were born in an age too soon!"

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Here we might rest our labors; but we cannot close our report without a few words of appeal which our subject suggests.

1. It appeals to *Physicians*. "The members of our profession," says an eminent medical authority, "who have already embarked in this most righteous crusade against physical corruption, cannot but feel themselves

encouraged by the sympathy and cooperation of the clergy; and who have not yet taken any part in furtherance of the cause, may perhaps find a motive to exertion in the interest with which it is regarded by the members of other professions, and by society at large. But a sense of duty, far more than the mere force of example, ought to enlist the medical man in this holy warfare. No member of society is to cognizant as he is of the facts of the case, or better prepared to interpret and enforce them; no one is less open to the suspicion of mean or unworthy motives; and no one has such frequent opportunities of converse with men of every degree. If he, who knows so much should appear indifferent or, what is worse,—from the bad habit of looking at the routine practice of his profession as the only honorable occupation of a medical man, and the work of palliation as his only duty,—should speak slightingly of this higher work prevention, and carp at the efforts of others on the pretence that they are given to exaggeration; society would soon catch his tone of thought and feeling; and a cause which, on reflection and careful examination, he would be constrained to support, must suffer irreparable injury. If, on the other hand he could be induced to exert himself heartily, but discretely in favor of sanitary measures, and to bring his influence to bear on those with whom his professional avocations place him in communication, it is impossible to over-estimate the good he may be the means of effecting."[51]

2. It appeals to *Clergymen*. Their official duties lead to visit the sick and the dying; and they should be forcibly impressed with the truth that the architect and the scavenger,—that sanitary reforms in their various modes of operation,—are their best colleagues. They should see and feel, that removing physical suffering and raising the social and personal condition of the sufferer, is the surest Way of gaining access to the heart, and of making their warnings, their instructions, and their consolations effectual; that the easiest and most permanent impressions are those made before the body and the mind become degraded in filth, stupefied by disease, or hardened and seared in guilt. In their personal intercourse and in their preaching, they should diffuse sanitary information, and urge the importance of sanitary measures. A weighty responsibility rests upon such men, and it becomes them to feel it, and to make themselves perfect masters of the subject, that they may use the information wisely and usefully in helping forward one of the greatest reforms of the age.

3. It appeals to *Educated men of all classes*. As a matter of intense interest, as a matter requiring profound investigation, as a matter of useful science, few subjects can be presented to an intelligent mind which promises more satisfactory results than the sanitary movement. For these objects alone it is worthy of being studied. But when it is viewed, in its personal and social relations to man and mind, it, in many respects, transcends all other matters. To those, who, by education, are qualified for the labor, few objects present a greater or more extended field of usefulness. Educated men and educated women too, who make themselves masters of sanitary science, may, by their pens, by their oratory, and by their personal influence, do an amount of good of which few or any or us have as yet an adequate conception. Such labors, judiciously conducted, would exert a mighty influence on the happiness of the race and its unborn millions. On such persons also rests a great responsibility. "I would beg you to consider," says Dr. Simon, "the incalculable good which may be conferred on the poorer classes of society by the direct educational influence of those in better and more enlightened circumstances. When I say that the social sanitary errors, to which I have particularly referred, would gradually but swiftly vanish under the influence of education, I do not mean that the cure would be in learning to read and to write, though these attainments, of course, would largely increase the present usefulness and market value of their possessor. The education to which I refer, as an all-important influence for sanitary progress, is that which would consist in exhibiting to the lowest classes of society frequent practical evidences of the attainability and of the advantages of higher civilization; an education which, by models and examples, would lead them to know cleanliness from dirt, decency from grossness, human propriety from brutish self-abandonment; an education which, by sensible experience, would teach them to feel the comfort and the profit of sanitary observances, and would apply their instinct of self preservation to the deliberate avoidance of disease." Lord Morpeth uttered this noble language in an address to his constituents, while the bill for promoting the public health was pending in parliament:—"Let my countrymen condemn me as they may, only do not let them hold me; do not hold the new parliament; do not let them hold themselves absolved, if they do not, either in their places as members of parliament, or as constituents keeping their representatives of their duty, insist upon early and efficient legislation on this subject."—"No one's conscience, be they ministers of state, be they members of parliament, be they members of corporations, or be they citizens of any class, ought to hold themselves harmless, if in time coming they offer any obstruction, or suffer any obstruction to be offered, to the immediate adoption of sanitary reform."[52]

4. It appeals to the *Wealthy and Philanthropic*. The munificent charities of the people of Massachusetts are well known. Many a one has given living or testamentary evidence that there runs through our society a strong current social sympathy, and a willingness and even a desire to dispose of portions of the wealth, which has been bestowed upon us, for the relief and elevation of suffering humanity. Among the different objects which present themselves for these noble sympathies, we solicit for the sanitary movement a careful examination. In our judgment no object is of more paramount interest and importance. Money used in collecting and diffusing sanitary information; in the establishment and maintenance of institutions designed to prevent sanitary evils; and in the various modes of operation which may be devised and carried forward by energetic and wise men, would prevent an amount of evil, and would accomplish an amount of good, promised by few or no other means.

5. It appeals to the *People*. This measure is, unlike many others, limited in its design and local or partial in its application. It reaches, and is intended to reach, every person in every part of the State. If adopted and properly carried into operation it will be universally felt,—by the professional man, the artisan and the laborer, by the rich and the poor; and the general salutary effects will be gradual but perceptible and great, upon the collective interests of the whole State, and upon the social and personal interests of each individual. Every man in every station has a direct interest in its success; and every one should do all in his power to establish and make it successful. Everyone should, as far as possible, endeavor to understand the character and design of the measure, and should commend its principles to others; he should unite in forming local sanitary associations; and in obtaining the passage of wise sanitary laws and regulations, and he should assist the public authorities in carrying them into operation. Every person should endeavor to reform whatever sanitary evils may exist in his own person and habits, and those of his family and neighborhood. And by these means the sanitary movement will be accelerated, and sooner accomplish the high and noble purposes for which it is destined.

The sanitary reform we advocate is not like some of the popular reforms of the age. It rests upon no visionary theories, conceived alone in the closet, or by some impracticable enthusiast. It aims at the establishment of no abstract principle, with no definite, practical bearing or application. It is not radical in its character or tendency; does not seek to overturn nor upturn any social, political or religious sentiment or institution; nor abrogate any constitutional or statute law. It interferes with no man's rights,—pecuniary, social, political or religious. But it takes things as they are; looks upon man as it finds him; allows him to enjoy the institutions with which he is favored; and *gives him the means of living longer, and of enjoying more while he does live*. There is in this no transcendentalism, or other ism or ology, to which any reasonable objection can be made; though it transcends, in its simplicity, in its practical utility, and its substantial, everyday, universal benefits, all other reforms. Every person, in every situation can do something to promote this reform; and every such effort wisely directed, will increase the amount of his own, individual enjoyment, and add to the aggregate enjoyment of the people of the whole Commonwealth.

6. It appeals to the *Periodical Press*. In this country almost every adult reads. Indulgence in the luxury of a newspaper is a universal characteristic of our people; and by the power of steam the press is able to furnish this luxury in an unprecedented manner and in any desirable quantity. We have watched with admiration, but not without fear, the growth and influence of the mighty power of the free periodical press. It educates, sways, shapes, and carries backward or forward, many an individual, and often the public, too, in a career of infamy or in a career of glory. It assumes an immense responsibility; and every press should feel it, and wield its influence for good and not for evil.

We have stated that the periodical press generally in England, has been in favor of sanitary reform. The "Times," the "Morning Chronicle," the "Daily News," the leading papers of Great Britain, and the exponents and guides of public opinion in their respective spheres, and the other less prominent publications of the daily press, as well as periodicals of a different class, have advocated the cause with a talent, discretion and perseverance, which reflect upon them the highest honor. The combined influence of the excellence of the cause, and of the force of public opinion, has silenced all opposition; and sanitary reform has now taken its place among the most prominent subjects of interest among all classes of people throughout the kingdom.

The subject appeals to the periodical press in this country to imitate so noble an example. It is a subject bounded by no sectional interests and no party lines, but is of universal concern and of unbounded application; and one in which press, of any character, may safely and properly embark. Every one that aids in its promotion advocates a measure which certainly can do no harm, and may,—judging from all past experience,—do immeasurable good; and everyone that opposes it, or throws obstacles in the way of its advancement, lends its aid, not only to defeat a harmless measure, but one designed to promote the progress and elevation of society and the best interests and well being of the human race. It will be an earnest of success if the periodical press shall zealously engage in this enterprise, as it will certainly find it for its interest to do, and support and defend the sanitary movement with the same talent and energy that is devoted to matters considered of the highest importance. Editors will there have discharged some what of the responsibility, which devolves upon them as guides of public opinion and well wishers to humanity.

7. It appeals to *Towns and Cities*. On the municipal authorities of towns and cities, depends the immediate execution of all sanitary laws and regulations. They are required to perform an important duty. Thorough knowledge of the condition of the people, and wise adaptation and administration of sanitary measures, will benefit and bless them. But blundering ignorance, or inconsiderate measures, or unwise administration, will not do it. Life, health, physical happiness, and even the moral condition of a town, may depend, in some degree, upon the adoption or rejection of proper sanitary regulations. An immense responsibility then rests upon these local authorities. And this impression should abide upon them, and they should be led to act accordingly. If they do not it will be known. Cholera in one district slays its thousands or its tens of thousands, and yet in another cannot find a single victim; and the cause of this difference is attributable to certain sanitary conditions present in one case,—absent in the other. Cholera, typhus, consumption, and other diseases, are "health inspectors, that speak in language which none can misunderstand; they visit persons on polluted rivers, the neglected lunatic in his cell, the crowded workshop, the establishments for pauper children, the sides of stagnant sewers, the undrained city, the uncleaned street, the cellar and the attic, as well as the fair open quarters which strangers frequent and admire. The oversights, the errors, the crimes of persons, who in responsible offices have charge of the health and life of men, are proclaimed aloud by their inexorable voices."[53]

8. It appeals to the *State*. Under our constitution and laws "each individual in society has a right to be protected in the enjoyment of his life." This may be considered in a sanitary as well as a murderous sense. And it is the duty of the states to extend over the people its guardian care, that those who cannot or will not protect themselves, may nevertheless be protected; and that those who can and desire to do it may have the means of doing it more easily. This right and authority should be exercised by wise laws, wisely administered; and when this is neglected the State should be held answerable for the consequences of this neglect. If legislators and public officers knew the number of lives unnecessarily destroyed, and the suffering unnecessarily occasioned by a wrong movement, or by no movement at all, this great matter would be more carefully studied, and errors would not be so frequently committed.

Massachusetts has always been eminent among the American states. Her metropolis has ever been the metropolis of New England. Her example has been imitated and has been felt, wherever the sons of New England are found or the name of New England is known. Her deeds are such as to justify even her own sons for an allusion to them.

Her puritan forefathers established the first system of self government, combining law and order with liberty and equality and based upon pure morality, universal education and freedom in religious opinion, as the only foundation which can insure its permanency and prosperity. And in her cradle was rocked the first child that drew its first breath under its benign influence.

She has her Concord, her Lexington, and her Bunker Hill, all marked; as the first battle-fields in that great struggle which severed the children from their soil was poured the blood of the most worthy and the most noble patriots the world has ever known; and "the bones of her sons, falling in the great struggle for independence, now lie mingled with the soil of every state from New England to Georgia, and there they will lie forever."

The thirteen united colonies furnished for the regular service of the revolutionary army, besides militia, 231,779 men,—an average of 17,830 each. Of these, Massachusetts furnished 67,907, or 29 per cent. of the whole, 35,968 more than any other state, and 50,077 men more than, or nearly four times, her equal proportion.[54] And she poured out her treasure for the outfit and support of her sons in the regular or militia service, and for the support of their families, whom they left behind, and for other public purposes, in nearly the same proportion, and with the same liberal hand, as she did her physical force and her blood.

She established, more than two hundred years ago, and near the beginning of her existence, free schools, open alike to all; and they have been cherished and supported, from that time to the present, by money drawn from the treasuries of towns, replenished by taxes on the inhabitants. She expended in this way, last year, for these free schools, $830,577.33,—a sum equal to $3.87 for every child in the State between the ages of four and sixteen. The whole State has been dotted over with schoolhouses like "sparkling diamonds in the heavens," giving intellectual light to all that come within their sphere.

She established in the United States the first system for the public registration of births, marriages and deaths, by which the personal history and identity, and the sanitary condition of the inhabitants, may be ascertained. She founded the first Blind Asylum; the first State Reform School; and aided in founding the first Deaf and Dumb Asylum; and her money, public and private, has flowed freely in the support of all the noble charities and religious enterprises of the age.

One of her sons first introduced into the United States the remedy of vaccination for the prevention of small-pox, which has deprived that terrific disease of its power, whenever used, and rendered its approach generally harmless. Another of her sons has the honor of making the great discovery of etherization, by means of whose wonderful capabilities the surgeon's instrument is deprived of its sting, and labor of its sorrow; the operator is permitted to pursue his work undisturbed, while the patient remains passive, unconscious, and unmoved by the horrors which, without it, might be inflicted. The blessings of this great prevention of human suffering are acknowledged and felt the world over. For these and very many other useful and honorable deeds which might be specified, she has been named, by distinguished men of other states and countries, "the forefather's land," "the moral state," "the enlightened state," "the patriotic state," "the philanthropic state," "the leading state," "the pattern state," "the noble state," "the glorious old Bay state." And many an ejaculation has gone up in all sincerity, "God bless her;" "God save the Commonwealth of Massachusetts!"

"There she stands;" a bright morning star in the system of the Union. On the pages of her history are recorded the noble deeds which have given her a good name and rendered her glorious. But her people demand at her hands a more full enjoyment of life, and a more abundant diffusion of its blessings; and no more noble and honorable and glorious page can anywhere be found, than that which shall record the adoption of some simple but efficient and comprehensive plan of Sanitary Reform; by which the greatest possible amount of physical power may be produced, of physical suffering may be prevented, and the greatest possible amount of physical, social and moral employment, may be attained. "This is the true glory which outlives all other; and shines with undying lustre, from generation to imparting to its works something of its own immortality."

All which is respectfully submitted.

Lemuel Shattuck,
N. P. Banks, Jr., Commissioners.
Jehiel Abbott,

Boston, *April 25, 1850*.

Source

Shattuck, Lemuel, et al. *Report of the Sanitary Commission of Massachusetts*. Boston: Dutton and Wentworth, 1850. A facsimile edition was printed in Cambridge, Massachusetts, by Harvard University Press in 1948. It is also online with an introduction by Larry Gordon at www.deltaomega.org/classics.htm.

CHAPTER 12

JOHN SNOW
(1813–1858)

Filthy water cannot be washed.
—African proverb

We're all downstream.
—Motto adopted for Windhorse Farm (a sustainable community), Nova Scotia

JOHN SNOW WAS BORN IN YORK, England, on March 15, 1813, the eldest of nine children born to William Snow and Francis (Askham) Snow. William Snow was a farmer, though he managed to accumulate sufficient wealth to purchase enough land to qualify as a landowner for the election of 1832. The family was decidedly working class, as it lived right by the Ouse River, with the omnipresent risk of flooding. The Snows' residential neighborhood was one of the worst drained sections of York, and the impact of such an environment during Snow's childhood undoubtedly influenced his subsequent thinking about the etiology of disease.

Snow was educated until the age of 14 at a common school for the area's poorest families. He then journeyed to Newcastle to apprentice with Mr. William Hardcastle, a physician from whom he learned the intricacies of running a general practice. At the conclusion of his training in 1833, he worked as an assistant to Dr. John Watson, an apothecary who practiced in an area near Newcastle. The year 1834 saw Snow's return to York, joining the practice of Mr. Joseph Warburton, a licensed apothecary. Apparently not satisfied with this setting, Snow moved to Soho in London in 1836 to take advanced study at the Hunterian School of Medicine. Sometime during 1836, Snow gave his first oration on behalf of a temperance society, indicating his belief that all poisons are taken in orally.

In May 1838, Snow became a member of the Royal College of Surgeons, and five months later, he received his apothecary license to practice medicine. He opened a practice in Soho and continued with his medical studies at the University of London. He was awarded a Bachelor of Medicine degree from that university in 1843 and, in 1844, a Doctor of Medicine degree.

In 1838, the first of Snow's publications appeared—a letter to the editor of the *Lancet* reporting on the dangers of using arsenic as a cadaver preservative. During the next three years, Snow published a variety of pieces in the *London Medical Gazette*, most of which focused on the physiology of respiration. Other publications followed, though there is no particular theme to them. It was not until the December 1846 introduction of anesthesia to England that Snow began his research into ether and chloroform. Within a year, he had published his first book on anesthesia, quickly establishing himself as the British authority on the topic. Snow attended Queen Victoria during the births of two of her children (in 1853 and 1857), administering anesthesia to eliminate the pain of labor.

Perhaps it was Snow's views regarding the mouth as the portal through which all poisons gained access to the body or perhaps it was his outstanding powers of observation that led to his theory of cholera as a waterborne infection. Snow's work on cholera began with his treatment of cholera patients during the 1832 outbreak. Yet it was not until the late 1840s, with his medical practice increasingly focused on the use of anesthesia, that Snow's attention turned to cholera and its etiology.

Snow's work on cholera is reflected in two publications, one in 1849 and a revision published in 1855. In these publications, Snow described his hypothesis regarding a waterborne microorganism as the agent for cholera, transmitted in the water supply and originating only from someone already infected. In 1854, cholera reappeared, and the toll from it quickly mounted. In one section of London near Snow's home in Soho, 600 persons died from the disease. Snow investigated and traced the outbreak back to the Broad Street pump. He presented the results of his investigation to the local parish leaders, who did nothing. Confronted with the ongoing epidemic, Snow went to the pump and removed the handle. Although the action has been viewed by many as the triumph of public health activism for over 150 years, the outbreak in the area around the pump had already crested and was in decline when Snow removed the pump handle.

William Farr, in the Office of the Registrar General, using the same data Snow had accessed, put forward an alternative theory for the 1854 cholera epidemic. He suggested it was related to altitude, that is, the higher one's house, the lower the risk of cholera. For most of the public health establishment, Farr's hypothesis not only fit the data as well as Snow's, but it also supported their view regarding the importance of sanitary improvements, most of which were being implemented in the lower-lying areas of London.

In 1855, Snow was elected president of the Medical Society of London. He was also an active participant in both the London Epidemiological Society and the Provincial Medical and Surgical Association after the publication of the 1849 pamphlet. He remained active in those societies after the appearance of the

1855 revised edition and presented papers at the former in support of his hypothesis. Although the 1855 book has inspired generations of epidemiologists, it was not viewed as compelling at the time of its publication.

In the wake of the appearance of cholera in 1854, the government undertook the restructuring of the public health establishment in London. Among the issues it wanted addressed was the air pollution generated by factories in south London. The solution put forward in proposed legislation was deemed so onerous some factories would have been shuttered. The factory owners appealed to Snow to testify to Parliament that the cause of the high rates of disease in south London was not their factories. Snow did so, earning the enmity of the *Lancet*, which blasted him in two editorials.

Snow died in London from the complications of a stroke that had incapacitated him on June 16, 1858.

During the 1866 outbreak of cholera in London, William Farr analyzed the mortality data for cholera and concluded Snow had been correct; altitude did not figure into the etiology of the disease.

A Note on the Text

In 1848, cholera reappeared in Britain, and the resulting epidemic continued into 1849. Against this background, Snow published the first of his two major pieces on cholera, a pamphlet titled simply *On The Mode Of Communication Of Cholera*. In this pamphlet, Snow detailed his theory of cholera as a disease caused by an agent transmitted in contaminated water. He suggested that water not contaminated by the agent (which had to come from another person already infected with it) would not transmit the disease. This theory presented a direct challenge to the sanitarians then in control of the nation's public health establishment. The medical community did not welcome Snow's hypothesis, with one reviewer opining, "There is, in our view, an entire failure of proof that the occurrence of any one case could be clearly and unambiguously assigned to water. . . . Notwithstanding our opinion that Dr. Snow has failed in proving that cholera is communicated in the mode in which he supposes it to be, he deserves the thanks of the profession for endeavouring to solve the mystery. It is only by close analysis of facts and the publication of new views, that we can hope to arrive at the truth." Significantly, Snow was not ostracized by the medical establishment for this publication, and he continued to be recognized for his work on anesthesia.

The return of cholera in 1854 provided the opportunity Snow needed to support his hypothesis, and he made the most of the opportunity. Snow recognized there had been a change in the water intake for the Lambeth Water Company after the 1849 outbreak. The Lambeth had moved its water intake from the

Thames upriver, reducing the chance of taking in water contaminated by the cholera discharges of those in London infected with the causal germ. In one section of south London, the Lambeth competed with the Southwark and Vauxhall Water Company, which had not changed its source of water supply. He then collected data reflecting deaths from cholera in this neighborhood in which the water supplies came from different sources, yet everything else was the same—a bona fide natural experiment. The cholera mortality rates among households using water supplied by Lambeth were much lower than for those using water provided by the Southwark and Vauxhall.

Snow also noted the occurrence of cholera in Golden Square, a short walk from his house. He mapped the cases and concluded that the Broad Street pump was the source of the outbreak. Snow observed the decline in the epidemic following his removal of the pump handle (though as noted above, the act probably had little to do with the decline). Third, Snow illustrated the extent to which his hypothesis accounted for many of the foci of cholera that had been observed in England generally and in London specifically.

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On The Mode Of Communication Of Cholera
(1854, Abridged)

[The first edition was a pamphlet, whereas later editions incorporated much additional material. Ed.]

The existence of Asiatic cholera cannot be distinctly traced back further than the year 1769. Previous to that time the greater part of India was unknown to European medical men; and this is probably the reason why the history of cholera does not extend to a more remote period. It has been proved by various documents, quoted by Mr. Scot,[1] that cholera was prevalent at Madras in the year above mentioned, and that it carried off many thousands of persons in the peninsula of India from that time to 1790. From this period we have very little account of the disease till 1814, although, of course, it might exist in many parts of Asia without coming under the notice of Europeans.

In June 1814, the cholera appeared with great severity in the 1st bat. 9th regt. N. I., on its march from Jaulnah to Trichinopoly; while another battalion, which accompanied it, did not suffer, although it had been exposed to exactly the same circumstances, with one exception. Mr. Cruikshanks, who attended the cases, made a report, which will be alluded to further on.

In 1817, the cholera prevailed with unusual virulence at several places in the Delta of The Ganges; and, as it had not been previously seen by the medical men practising in that part of India, it was thought by them to be a new disease. At this time the cholera began to spread to an extent not before known; and, in the course of seven years, it reached, eastward, to China and the Philippine Islands; southward, to the Mauritius and Bourbon; and to the north-west, as far as Persia and Turkey. Its approach towards our own country, after it entered Europe, was watched with more intense anxiety than its progress in other directions. It would occupy a long time to give an account of the progress of cholera over different parts of the world, with the devastation it has caused in some places, whilst it has passed lightly over others, or left them untouched; and unless this account could be accompanied with a description of the physical condition of the places, and the habits of the people, which I am unable to give, it would be of little use.

There are certain circumstances, however, connected with the progress of cholera, which may be stated in a general way. It travels along the great tracks of human intercourse, never going faster than people travel, and generally much more slowly. In extending to a fresh island or continent, it always appears first at a seaport. It never attacks the crews of ships going from a country free from cholera, to one where the disease is prevailing, till they have entered a port, or had intercourse with the shore. Its exact progress from town to town cannot always be traced; but it has never appeared except where there has been ample opportunity for it to be conveyed by human intercourse.

There are also innumerable instances which prove the communication of cholera, by individual cases of the disease, in the most convincing manner. Instances such as the following seem free from every source of fallacy.

I called lately to inquire respecting the death of Mrs. Gore, the wife of a labourer, from cholera, at New Leigham Road, Streatham. I found that a son of deceased had been living and working at Chelsea. He came home ill with a bowel complaint, of which he died in a day or two. His death took place on August 18th. His mother, who attended on him, was taken ill on the next day, and died the day following (August 20th). There were no other deaths from cholera registered in any of the metropolitan districts, down to the 26th August, within two or three miles of the above place; the nearest being at Brixton, Norwood, or Lower Tooting.

The first case of decided Asiatic cholera in London, in the autumn of 1848, was that of a seaman named John Harnold, who had newly arrived by the *Elbe* steamer from Hamburgh, where the disease was prevailing. He left the vessel, and went to live at No. 8, New Lane, Gainsford Street, Horsleydown. He was seized with cholera on the 22nd of September, and died in a few hours. Dr. Parkes, who made an inquiry into the early cases of cholera, on behalf of the then Board of Health, considered this as the first undoubted case of cholera.

Now the next case of cholera, in London, occurred in the very room in which the above patient died. A man named Blenkinsopp came to lodge in the same room. He was attacked with cholera on the 30th September, and was attended by Mr. Russell of Thornton Street, Horsleydown, who had attended John Harnold. Mr. Russell informed me that, in the case of Blenkinsopp, there were rice-water evacuations; and, amongst other decided symptoms of cholera, complete suppression of urine from Saturday till Tuesday morning; and after this the patient had consecutive fever. Mr. Russell had seen a great deal of cholera in 1832, and considered this a genuine case of the disease; and the history of it leaves no room for doubt.

[Several pages of letters from other physicians citing their experiences in treating cholera patients have been deleted here. Ed.]

It would be easy, by going through the medical journals and works which have been published on cholera, to quote as many cases similar to the above as would fill a large volume. But the above instances are quite sufficient to show that cholera can be communicated from the sick to the healthy; for it is quite impossible that even a tenth part of these cases of consecutive illness could have followed each other by mere coincidence, without being connected as cause and effect.

Besides the facts above mentioned, which prove that cholera is communicated from person to person, there are others which show, first, that being present in the same room with a patient, and attending on him, do not necessarily expose a person to the morbid poison; and, secondly, that it is not always requisite that a person should be very near a cholera patient in order to take the disease, as the morbid matter producing it may be transmitted to a distance. It used to be generally assumed, that if cholera were a catching or communicable disease, it must spread by effluvia given off from the patient into the surrounding air, and inhaled by others into the lungs. This assumption led to very conflicting opinions respecting the disease. A little reflection shows, however, that we have no right thus to limit the way in which a disease may be propagated, for the communicable diseases of which we have a correct knowledge spread in very different manners. The itch, and certain other diseases of the skin, are propagated in one way; syphilis, in another way; and intestinal worms in a third way, quite distinct from either of the others.

A consideration of the pathology of cholera is capable of indicating to us the manner in which the disease is communicated. If it were ushered in by fever, or any other general constitutional disorder, then we should be furnished with no clue to the way in which the morbid poison enters the system; whether, for instance, by the alimentary canal, by the lungs, or in some other manner, but should be left to determine this point by circumstances unconnected with the pathology of the disease. But from all that I have been able to learn of cholera, both from my own observations and the descriptions of others, I conclude that cholera invariably commences with the affection of the alimentary canal. The disease often proceeds with so little feeling of general illness, that the patient does not consider himself in danger, or even apply for advice, till the malady is far advanced. In a few cases, indeed, there are dizziness, faintness, and a feeling of sinking, before discharges from the stomach or bowels actually take place; but there can be no doubt that these symptoms depend on the exudation from the mucous membrane, which is soon afterwards copiously evacuated. This is only what occurs in certain cases of hemorrhage into the alimentary canal, where all the symptoms of loss of blood are present before that fluid shows itself in the evacuations. In those rare cases, called "cholera sicca," in which no purging takes place, the intestines have been found distended with the excretion peculiar to the disease, whenever an examination of the body has taken place after death. In all the cases of cholera that I have attended, the loss of fluid from the stomach and bowels has been sufficient to account for the collapse, when the previous condition of the patient was taken into account, together with the suddenness of the loss, and the circumstance that the process of absorption appears to be suspended.

The symptoms which follow the affection of the alimentary canal in cholera are exactly those which this affection is adequate, and, indeed, could not fail to produce. The analyses which have been made of the blood of cholera patients show that the watery fluid effused into the stomach and bowels is not replaced by absorption, or is replaced only to a small extent. The analyses of Dr. O'Shaughnessy and others, during the cholera of 1831–32, show that the amount of water in the blood was very much diminished in proportion to the solid constituents, and that the salts of the blood were also diminished. The analyses of Dr. Garrod and Dr. Parkes, in the spring of 1849, were more numerous and exact.[2] The amount of water in the blood of healthy persons is on the average 785 parts in 1000; whereas, in the average of the analyses performed by Drs. Garrod and Parkes, it was only 733 parts, while the amount of solid constituents of the blood, relatively to the water, was increased from 215—the healthy standard—to 267. The globules, together with the albumen and other organic constituents of the serum, amount in the healthy state to 208 parts in 1000, while in the blood of cholera patients they amounted to 256 parts. The saline constituents in 1000 parts of blood are somewhat increased, on account of the great diminution of water; but, when estimated in relation to the other solid ingredients or to the whole quantity existing, in the healthy body, the amount is diminished. Dr. Garrod is of opinion that a chemical analysis will determine whether or not a specimen of blood has been derived from a cholera patient.

The stools and vomited matters in cholera consist of water, containing a small quantity of the salts of the blood, and a very little albuminous substance. The change in the blood is precisely that which the loss by the alimentary canal ought to produce; and, indeed, it is physically impossible that the alteration in the blood can be caused in any other way. The sweating which takes place in an advanced stage of the disease may increase the density of the blood to a trifling extent; but it does not come on till the blood is already altered, and it is only a consequence of the diminished force of the circulation, like the sweating met with in collapse from hemorrhage or severe injuries, and in faintness from venesection.

The loss of water from the blood causes it to assume the thick tarry appearance, so well known to all who have opened a vein in cholera. The diminished volume of the blood causes many of the symptoms of a true hemorrhage, as debility, faintness, and coldness; while these effects are much increased by its thick and tenacious condition, which impedes its passage through the pulmonary capillaries, thereby reducing the contents of the arteries throughout the system to the smallest possible amount, as indicated by the small thready pulse. The interruption to the pulmonary circulation occasioned by the want of fluidity of the blood is the cause of the distressing feeling of want of breath. Proofs of the obstructed circulation through the lungs generally remain after death, in the distended state of the pulmonary arteries and right cavities of the heart. The deficient supply of blood to the various organs, and its unfitness to pass through the capillaries are the cause of the suppression of the renal, biliary, and other secretions. The cramps appear to consist chiefly of reflex action, caused by the irritation, and probably the distension, of the bowels.

If any further proof were wanting, than those above stated, that all the symptoms attending cholera, except those connected with the alimentary canal, depend simply on the physical alteration of the blood, and not on any cholera poison circulating in the system, it would only be necessary to allude to the effects of a weak saline solution injected into the veins in the stage of collapse. The shrunken skin becomes filled out, and loses its coldness and lividity; the countenance assumes a natural aspect; the patient is able to sit up, and for a time seems well. If the symptoms were caused by a poison circulating in the blood, and depressing the action of the heart, it is impossible that they should thus be suspended by an injection of warm water, holding a little carbonate of soda in solution.

It has often been contended that the collapse of cholera cannot be the mere result of the purging and vomiting, because, in some of the most rapid and malignant cases, the amount of the stools and vomited fluid is less than in milder and more protracted ones, or even in some cases in which the patients recover. But, in the most rapid and malignant cases, there is sufficient loss of aqueous fluid by the alimentary canal to alter the blood into the thick tenacious state peculiar to this disease; and the fact of more purging occurring in other cases which are more protracted, only proves that, in these latter, absorption from the stomach and intestines has not been altogether arrested, or that the stools have been diluted with fluids drank by the patient. The loss of fluid in every case of fully developed cholera must be sufficient to cause the thickened state of the blood, which is the cause of the algide symptoms; and the amount of malignancy of the case must depend chiefly on the extent to which the function of absorption is impaired.

If absorption were altogether arrested in every case of cholera from the beginning, the amount of discharge from the alimentary canal would not equal that of a fatal hemorrhage, for the thickened blood which remains is certainly not able to maintain life so well as the same quantity of healthy blood. Indeed, it is easy to calculate the amount of fluid separated from the blood, by means of the analyses previously quoted, and others which have been made of the cholera stools. In some analyses of these evacuations made by Dr. Parkes,[3] the average composition in 1000 parts was found to be 982.4 water and 17.6 solids; consequently, the problem is merely to find how much of such a fluid requires to be subtracted from blood consisting of water 785 and solids 215, in 1000 parts, in order to reduce it to blood consisting of water 733 and solids 267. The answer to this problem is that 208.5 parts would require to be subtracted from 1000 parts of blood. M. Valentin has estimated the average amount of blood in the human adult at thirty pounds; and, therefore, the whole quantity of fluid that requires to be effused into the stomach and bowels, in order to reduce the blood of a healthy adult individual to the condition in which it is met with in the collapse of cholera is, on the average, 100 ounces, or five imperial pints. This calculation may be useful as indicating the amount of fluid which ought not to be exceeded in the injection of the blood vessels.

Diseases which are communicated from person to person are caused by some material which passes from the sick to the healthy, and which has the property of increasing and multiplying in the systems of the persons it attacks. In syphilis, smallpox, and vaccinia, we have physical proof of the increase of the morbid material, and in other communicable diseases the evidence of this increase, derived from the fact of their extension, is equally conclusive. As cholera commences with an affection of the alimentary canal, and as we have seen that the blood is not under the influence of any poison in the early stages of this disease,[4] it follows that the morbid material producing cholera must be introduced into the alimentary canal—must, in fact, be swallowed accidentally, for persons would not take it intentionally; and the increase of the morbid material, or cholera poison, must take place in the interior of the stomach and bowels. It would seem that the cholera poison, when reproduced in sufficient quantity, acts as an irritant on the surface of the stomach and intestines, or, what is still more probable, it withdraws fluid from the blood circulating in the capillaries, by a power analogous to that by which the epithelial cells of the various organs abstract the different secretions in the healthy body. For the morbid matter of cholera having the property of reproducing its own kind, must necessarily have some sort of structure, most likely that of a cell. It is no objection to this view that the structure of the cholera poison cannot be recognized by the microscope, for the matter of smallpox and of chance can only be recognized by their effects, and not by their physical properties.

The period which intervenes between the time when a morbid poison enters the system, and the commencement of the illness which follows, is called the period of incubation. It is, in reality, a period of reproduction, as regards the morbid matter; and the disease is due to the crop or progeny resulting from the small quantity of poison first introduced. In cholera, this period of incubation or reproduction is much shorter than in most other epidemic or communicable diseases. From the cases previously detailed, it is shown to be in general only from twenty-four to forty-eight hours. It is owing to this shortness of the period of incubation, and to the quantity of the morbid poison thrown off in the evacuations, that cholera sometimes spreads with a rapidity unknown in other diseases.

The mode of communication of cholera might have been the same as it is, even if it had been a disease of the blood; for there is a good deal of evidence to show that plague, typhoid fever, and yellow fever, diseases in which the blood is affected, are propagated in the same way as cholera. There is sufficient evidence also, I believe, in the following pages, to prove the mode of communication of cholera here explained, independently of the pathology of the disease; but it was from considerations of its pathology that the mode of communication was first explained, and, if the views here propounded are correct, we had a knowledge of cholera, before it had been twenty years in Europe, more correct than that of most of the older epidemics; a knowledge which, indeed, promises to throw much light on the mode of propagation of many diseases which have been present here for centuries.

The instances in which minute quantities of the ejections and defections of cholera patients must be swallowed are sufficiently numerous to account for the spread of the disease; and on examination it is found to spread most where the facilities for this mode of communication are greatest. Nothing has been found to favour the extension of cholera more than want of personal cleanliness, whether arising from habit or scarcity of water, although the circumstance till lately remained, unexplained. The bed linen nearly always becomes wetted by the cholera evacuations, and as these are devoid of the usual color and odour, the hands of persons waiting on the patient become, soiled without their knowing it: and unless these persons are scrupulously cleanly in their habits, and wash their hands before taking food, they must accidentally swallow some of the excretion, and leave some on the food they handle or prepare, which has to be eaten by the rest of the family, who, amongst the working classes, often have to take their meals in the sick room: hence the thousands of instances in which, amongst this class of the population, a case of cholera in one member of the family is followed by other cases; whilst medical men and others, who merely visit the patients, generally escape. The *post mortem* inspection of the bodies of cholera patients has hardly ever been followed by the disease that I am aware; this being a duty that is necessarily followed by careful washing of the hands; and it is not the habit of medical men to be taking food on such an occasion. On the other hand, the duties performed about the body, such as laying it out, when done by women of the working class, who make the occasion one of eating and drinking, are often followed by an attack of cholera; and persons who merely attend the funeral, and have no connection with the body, frequently contract the disease, in consequence, apparently, of partaking of food which has been prepared or handled by those having duties about the cholera patient, or his linen and bedding.

Deficiency of light is a great obstacle to cleanliness, as it prevents dirt from being seen, and it must aid very much the contamination of the food with the cholera evacuations. Now the want of light, in some of the dwellings of the poor, in large towns, is one of the circumstances that has often been commented on as increasing the prevalence of cholera.

The involuntary passage of the evacuations in most bad cases of cholera, must also aid in spreading the disease. Mr. Baker, of Staines, who attended two hundred and sixty cases of cholera and diarrhoea in 1849, chiefly among the poor, informed me, in a letter with which he favoured me in December of that year, that "when the patients passed their stools involuntarily the disease evidently spread." It is amongst the poor, where a whole family live, sleep, cook, eat, and wash in a single room, that cholera has been found to spread when once introduced, and still more in those places termed common lodging houses, in which several families were crowded into a single room. It was amongst the vagrant class, who lived in this crowded state, that cholera was most fatal in 1832; but the Act of Parliament for the regulation of common lodging-houses, has caused the disease to be much less fatal amongst these people in the late epidemics. When, on the other hand, cholera is introduced into the better kind of houses, as it often is, by means that will be afterwards pointed out, it hardly ever spreads from one member of the family to another. The constant use of the hand-basin and towel, and the fact of the apartments for cooking and eating being distinct from the sick room, are the cause of this.

The great prevalence of cholera in institutions for pauper children and pauper lunatics, whenever it has gained access to these buildings, meets with a satisfactory explanation according to the principles here laid down. In the asylum for pauper children at Tooting, one hundred and forty deaths from cholera occurred amongst a thousand inmates, and the disease did not cease till the remaining children had been removed. The children were placed two or three in a bed, and vomited over each other when they had the cholera. Under these circumstances, and when it is remembered that children get their hands into everything, and are constantly putting their fingers in their mouths, it is not surprising, that the malady spread in this manner, although I believe as much attention was paid to cleanliness as is possible in a building crowded with children. Pauper lunatics are generally a good deal crowded together, especially in their sleeping wards, and as the greater number of them are in a state of imbecility, they are no more careful than children in the use of their hands. It is with the greatest difficulty that they can be kept even moderately clean. As might be expected, according to the views here explained, the lunatic patients generally suffered in a much greater proportion than the keepers and other attendants.

The mining population of Great Britain have suffered more from cholera than persons in any other occupation, a circumstance which I believe can only be explained by the mode of communication of the malady above pointed out. Pitmen are differently situated from every other class of workmen in many important particulars. There are no privies in the coal-pits, or, as I believe, in other mines. The workmen stay so long in the mines that they are obliged to take a supply of food with them, which they eat invariably with unwashed hands, and without knife and fork. The following is a reply which I received from a relative of mine connected with a colliery near Leeds, in answer to an inquiry I made:—

> *Our colliers descend at five o'clock in the morning, to be ready for work at six, and leave the pit from one to half-past three. The average time spent in the pit is eight to nine hours. The pitmen take down with them a supply of food, which consists of cake, with the addition, in some cases, of meat; and all have a bottle, containing about a quart of 'drink.' I fear that our colliers are no better than others as regards cleanliness. The pit is one huge privy, and of course the men always take their victuals with unwashed hands.*

It is very evident that, when a pitman is attacked with cholera whilst at work, the disease has facilities for spreading among his fellow-labourers such as occur in no other occupation. That the men are occasionally attacked whilst at work I know, from having seen them brought up from some of the coal-pits in Northumberland, in the winter of 1831–2, after having had, profuse discharges from the stomach and bowels, and when fast approaching to a state of collapse.

Dr. Baly, who has done me the honour of giving a very full and impartial account of my views in his "Report on Cholera to the College of Physicians," makes the objection to what I have said about the colliers, that the women and children who do not work in the mines, were attacked in as large numbers as the men. I believe, however, that this is only what ought to occur from the propagation of the cholera in the crowded dwellings of the pitmen, in the manner previously explained. The only effect of its communication in the pits would be, that the men and boys in a family would have the cholera a day or two earlier than the women and children; and if a special inquiry were made on this point, this would probably be found to be the case. It has often been said that, if cholera were a communicable disease, women ought to suffer in much greater numbers than the men, as they are employed in nursing the sick. I leave this objection and Dr. Baly's to combat each other.

It is very probable that, when cholera occurs amongst people who are employed in the preparation or vending of provisions, the disease may be spread by this means, although from the nature of the subject it is hardly to be expected that the fact would be discovered. The following cases, perhaps, afford as decisive proof of this variety of communication of cholera as can be expected. In the beginning of 1850, a letter appeared in the Provincial Medical and Surgical Journal, from Mr. John C. Bloxam, in the Isle of Wight, being an answer to the inquiry on cholera by Mr. Hunt. Among other interesting information, Mr. Bloxam stated, that the only cases of cholera that occurred in the village of Carisbrook, happened in persons who ate of some stale cow-heels, which had been the property of a man who died in Newport, after a short and violent attack of cholera. Mr. Bloxam kindly made additional personal inquiries into the case, in consequence of questions I put to him, and the following is a summary of the information contained in his letter:—

The man from whose house the cow-heels were sent for sale died on Monday, the 20th of August. It was the custom in the house to boil these articles on Monday, Wednesday, and Friday; and the cow-heels under consideration were taken to Carisbrook, which is a mile from Newport, ready boiled, on Tuesday the 21st. Eleven persons in all partook of this food, seven of whom ate it without any additional cooking. Six of these were taken ill within twenty-four hours after eating it, five of whom died, and one recovered. The seventh individual, a child, who ate but a small quantity of the cow-heels, was unaffected by it. Four persons partook of the food after additional cooking. In one case the cow-heels were fried, and the person who ate them was taken ill of cholera within twenty-four hours afterwards, and died. Some of the food was made into broth, of which three persons partook while it was warm; two of them remained well, but the third person partook again of the broth next day, when cold, and, within twenty-four hours after this latter meal, she was taken ill with cholera, of which she died. It may be proper to mention, although it is no unusual circumstance for animal food to be eaten in hot weather when not quite fresh, that some of the persons perceived the cow-heels to be not so fresh as they ought to have been at the time they were eaten, and part of them had to be thrown away a day or two afterwards, in consequence of being quite putrid.

It is not unlikely that some of the cases of cholera which spring up without any apparent connection with previous cases may be communicated through articles of diet. It is the practice of the poor people, who gain a living by selling fruit and other articles in the streets, to keep their stock in very crowded rooms in which they live, and, when visiting the out-patients of a medical charity a few years ago, I often saw baskets of fruit pushed under the beds of sick patients, in close proximity with the chamber utensils. I need hardly say that if cases of disease were propagated in this way, it would be quite impossible to trace them.

If the cholera had no other means of communication than those which we have been considering, it would be constrained to confine itself chiefly to the crowded dwellings of the poor, and would be continually liable to die out accidentally in a place, for want of the opportunity to reach fresh victims; but there is often a way open for it to extend itself more widely, and to reach the well-to-do classes of the community; I allude to the mixture of the cholera evacuations with the water used for drinking and culinary purposes, either by permeating the ground, and getting into wells, or by running along channels and sewers into the rivers from which entire towns are sometimes supplied with water.

In 1849 there were in Thomas Street, Horsleydown, two courts close together, consisting of a number of small houses or cottages, inhabited by poor people. The houses occupied one side of each court or alley—the south side of Trusscott's Court, and the north side of the other, which was called Surrey Buildings, being placed back to back, with an intervening space, divided into small back areas, in which were situated the privies of both the courts, communicating with the same drain, and there was an open sewer which passed the further end of both courts. Now, in Surrey Buildings the cholera committed fearful devastation, whilst in the adjoining court there was but one fatal case, and another case that ended in recovery. In the former court, the slops of dirty water, poured down by the inhabitants into a channel in front of the houses, got into the well from which they obtained their water; this being the only difference that Mr. Grant, the Assistant for the Commissioners of Sewers, could find between the circumstances of the two courts, as he stated in a report that he made to the Commissioners. The well in question was supplied from the pipes of the Southwark and Vauxhall Waterworks, and was covered in on a level with the adjoining ground; and the inhabitants obtained the water by a pump placed over the well. The channel mentioned above commenced close by the pump. Owing to something being out of order, the water had for some time occasionally burst out at the top of the well, and overflowed into the gutter or channel, afterwards flowing back again mixed with the impurities; and crevices were left in the ground or pavement, allowing, part of the contents of the gutter to flow at all times into the well; and when it was afterwards emptied, a large quantity of black and highly offensive deposit was found.

The first case of cholera in this court occurred on July 20th, in a little girl, who had been labouring under diarrhoea for four days. This case ended favourably. On the 21st July, the next day, an elderly female was attacked with the disease, and was in a state of collapse at ten o'clock the same night. This patient partially recovered, but died of some consecutive affection on August 1st. Mr. Vinen, of Tooley Street, who attended these cases, states that the evacuations were passed into the beds, and that the water in which the foul linen was washed would inevitably be emptied into the channel mentioned above. Mr. Russell, of Thornton Street, Horsleydown, who attended many of the subsequent cases in the court, and who, along with another medical gentleman, was to call the attention of the authorities to the state of the well, says that such water was invariably emptied there, and the people admit the circumstance. About a week after the above two cases commenced, a number of patients were taken ill nearly together: four on Saturday, July 28th, seven or eight on the 29th, and several on the day following. The deaths in the cases that were fatal took place as follows:—one on the 29th, four on the 30th, and one on the 31st July; two on August 1st, and one on August the 2nd, 5th, and 10th respectively, making eleven in all. They occurred in seven out of the fourteen small houses situated in the court.

The two first cases on the 20th and 21st were probably caused by the cholera evacuations contained in the Thames water, as it came from the waterworks, and they may be considered to represent about the average amount of cases for the neighbourhood, there having been just that number in the adjoining court, about the same time. But in a few days, when the dejections of these patients must have become mixed with the water the people drank, a number of additional cases commenced nearly together. The patients were all women and children, the men living in the court not having been attacked; they may have been out at work all day and not have drank the water, but as the surviving inhabitants nearly all left the place immediately after the above mortality occurred, I was not able to ascertain whether this was so or not.

In Albion Terrace, Wandsworth Road, there was an extraordinary mortality from cholera in 1849, which was the more striking as there were no other cases at the time in the immediate neighbourhood; the houses opposite to, behind, and in the same line, at each end of those in which the disease prevailed, having been free from it. The row of houses in which the cholera prevailed to an extent probably at that time quite unprecedented in this country, constituted the genteel suburban dwellings of a number of professional and trades people, and are most of them detached a few feet from each other. They were supplied with water on the same plan. In this instance the water got contaminated by the contents of the house drains and cesspools. The cholera extended to nearly all the houses in which the water was thus tainted, and to no others.

These houses were numbered from 1 to 17, in Albion Terrace, and were supplied with water from a copious spring in the road in front of the terrace, the water of which was conducted, by a brick barrel-drain between Nos. 7 and 8, to the back of the houses, and then flowed right and left, to supply tanks in the ground behind each house, the tanks being made of brickwork and cement, covered with a flat stone, and connected with each other by stoneware pipes six inches in diameter. A leaden pipe conveyed water from each tank to a pump situated in the back kitchen. There was a cesspool behind each house, under the privy, and situated four feet from the water tank. The ground was opened behind the houses No.1 and No. 7, and the drains examined under the superintendence of Mr. Grant, the Assistant-Surveyor to the Commissioners of Sewers. The cesspools at both these places were quite full, and the overflow-drain from that at No. 1 choked up. At this house the respective levels of the cesspool and the water-tank were measured, and the top of the overflow-drain from the cesspool was found to be fifteen inches above the top of the tank, and the intervening ground was very wet. The overflow drain mentioned above had no bottom, or one so soft that it could be penetrated with a stick; and it crossed, at right angles, above the earthenware pipe of the water-tank, the joints of which were leaky, and allowed the water to escape. Behind No. 7, Mr. Grant found a pipe for bringing surplus water from the tanks, communicating with a drain from the cesspool; and he found a flat brick drain laid over the barrel-drain before mentioned, which brought the water from the spring. It appears, from a plan of the property, that this drain, which was continued in a direction towards the sewer in Battersea Fields, brought surface-drainage from the road, and received the drains from the cesspools, the house-drains from the sinks in the back kitchens, and the surplus water, or some of it, from the tanks. There was every reason to believe that this drain was stopped up, but that was not ascertained: at all events it as unable to convey the water flowing into it during the storm on July 26th, as it burst near the house No. 8, and inundated the lower premises of that and the adjoining house, No. 9 with fetid water—and it was from this time that the water, which had occasionally been complained of before, was found by most of the people in these seventeen houses to be more or less impure or disagreeable. The water broke out of the drain again at No. 8, and overflowed the kitchens, during a heavy rain on August 2nd. It should be particularly remarked, that the tanks were placed on the same level, so that pumping from one would draw water from the others, and that any impurity getting into one tank would consequently be imparted to the rest.

The first case of cholera occurred at No. 13, on July 28th (two days after the bursting of the drain), in a lady who had had premonitory symptoms for three or four days. It was fatal in fourteen hours. There was an accumulation of rubbish in the cellar of this house, which was said to be offensive by the person who removed it; but the proprietor of the house denied this. A lady at No. 8 was attacked with choleraic diarrhoea on July 30th: she recovered. On August 1st, a lady, aged eighty-one, at No. 6, who had had some diarrhoea eight or ten days before, which had yielded to her own treatment, was attacked with cholera: she died on the 4th with congested brain. Diarrhoea commenced on August 1st in a lady aged 60, at No. 3; collapse took place on the 5th, and death on the 6th. On August 3rd, there were three or four cases, in different parts of the row of houses, and two of them terminated fatally on the same day. The attacks were numerous during the following three or four days, and after that time they diminished in number. More than half the inhabitants of the part of the terrace in which the cholera prevailed, were attacked with it, and upwards of half the cases were fatal. The deaths occurred as follows; but as some of the patients lingered a few days, and died in the consecutive fever, the deaths are less closely grouped than the seizures. There was one death on July 28th, two on August 3rd, four on the 4th, two on the 6th, two on the 7th, four on the 8th, three on the 9th, one on the 11th, and one on the 13th. These make twenty fatal cases; and there were four or five deaths besides amongst those who were attacked after flying from the place.

The fatal cases were distributed over ten out of the seventeen houses and Mr. Mimpriss of Wandsworth Road, who attended many of the cases, and to whose kindness I am indebted for several of these particulars, stated that cases occurred in the other seven houses, with the exception of one or two that were empty, or nearly so. There were five deaths in the house No. 6; and one of a gentleman the day after he left it, and went to Hampstead Heath. The entire household, consisting of seven individuals, had the cholera, and six of them died.

There are no data for showing how the disease was communicated to the first patient, at No. 13, on July 28th; but it was two or three days afterwards, when the evacuations from this patient must have entered the drains having a communication with the water supplied to all the houses, that other persons were attacked, and in two days more the disease prevailed to an alarming extent.

I had an opportunity of examining some of the water removed by Mr. Grant from the tanks behind the houses No. 1 and No. 7, and also some of the deposit which lay in the tanks to the depth of from six to nine inches. The water was offensive, and the deposit possessed the odour of privy soil very distinctly, I found in it various substances which had passed through the alimentary canal, having escaped digestion, as the stones and husks of currants and grapes, and portions of the thin epidermis of other fruits and vegetables. Many of the patients attributed their illness to the water. This is here mentioned to show that they had drunk of it, and at the same time found that it was impure. As explaining, how persons might drink of such water before finding out its impurity, it may be stated that the grosser part of the material from drains and cesspools has a tendency, when mixed with water, to settle rapidly to the bottom. The only houses supplied with the same water, after passing the tanks in Albion Terrace, were four in Albion Street; but three of these had been empty for months, and the fourth was inhabited by a gentleman who always suspected the water, and would not drink it. There were two or three persons attacked with cholera amongst those who came to nurse the patients after the water was condemned, and who, consequently, did not drink it; but these persons were liable, in waiting on the patient, to get a small portion of the evacuations into the stomach in the way first pointed out; and there might be food in the houses, previously prepared with the tainted water. It is not here implied that every one of the cases in Albion Terrace was communicated by the water, but that far the greater portion of them were; that, in short, it was the circumstance of the cholera evacuations getting into the water, which caused the disease to spread so much beyond its ordinary extent.

The mortality in Albion Terrace was attributed by Dr. Milroy, in a published report to the General Board of Health, chiefly to three causes: first, to an open sewer in Battersea Fields, which is four hundred feet to the north of the terrace, and from which the inhabitants perceived a disagreeable odour when the wind was in certain directions; secondly, to a disagreeable odour from the sinks in the back kitchens of the houses, which was worse after the storm of July 26th; and lastly, to the accumulation in the house No. 13, before alluded to. With respect to the open sewer, there are several streets and lines of houses as much exposed to any emanations there might be from it, as those in which the cholera prevailed: and yet they were quite free from the malady, as were also nineteen houses situated between the sewer and Albion Terrace. As regards the bad smells from the sinks in the kitchen, their existence is of such every-day and almost universal prevalence, that they do not help to explain an irruption of cholera like that under consideration; indeed, offensive odours were created in thousands of houses in London by the same storm of rain on July 26th; and the two houses in which the offensive smell was greatest, *viz.* Nos. 8 and 9–those which were flooded with the contents of the drain—were less severely visited with cholera than the rest; the inhabitants having only had diarrhoea, or mild attacks of cholera. The accumulation in the house No. 13 could not affect the houses at a distance from it. It remains evident then, that the only special and peculiar cause connected with the great calamity which befel the inhabitants of these houses, was the state of the water, which was followed by the cholera in almost every house to which it extended, whilst all the surrounding houses were quite free from the disease. Indeed, the General Board of Health attributed the mortality at this place to the contamination of the water, in a manifesto which they published not long after Dr. Milroy's report.[5]

Dr. Lloyd mentioned some instances of the effects of impure water at the South London Medical Society, on August 30th, 1849.[6] In Silver Street, Rotherhithe, there were eighty cases, and thirty-eight deaths, in the course of a fortnight early in July of that year, at a time when there was very little cholera in any other part of Rotherhithe. The contents of all the privies in this street ran into a drain which had once had a communication with the Thames; and the people well situated very near the end of the drain, with the contents of which the water got contaminated. Dr. Lloyd informed me that the fetid water from the drain could be seen dribbling through the side of the well, above the surface of the water. Amongst other sanitary measures recommended by Dr. Lloyd was the filling up of the well; and the cholera ceased in Silver Street as soon as the people gave over using the water. Another instance alluded to by Dr. Lloyd, was Charlotte Place, in Rotherhithe, consisting of seven houses, the inhabitants of which, excepting those of one house, obtained their water from a ditch communicating with the Thames, and receiving the contents of the privies of all the seven houses. In these houses there were twenty-five cases of cholera, and fourteen deaths; one of the houses had a pump railed off, to which the inhabitants of the other houses had no access, and there was but one case in that house.

The following instance, as well as some others of a similar kind, is related in the "Report of the General Board of Health on the Cholera of 1848 and 1849."

> *In Manchester, a sudden and violent outbreak of cholera occurred in Hope Street, Salford. The inhabitants used water from a particular pump-well. This well had been repaired, and a sewer which passes within nine inches of the edge of it became accidentally stopped up, and leaked into the well. The inhabitants of thirty houses used the water from this well; among them there occurred nineteen cases of diarrhoea, twenty-six cases of cholera, and twenty-five deaths. The inhabitants of sixty houses in the same immediate neighbourhood used other water; among these there occurred eleven cases of diarrhoea but not a single case of cholera, nor one death. It is remarkable, that, in this instance, out of the twenty-six persons attacked with cholera, the whole perished except one.* (p. 62)

Dr. Thomas King Chambers informed me, that at Ilford, in Essex, in the summer of 1849, the cholera prevailed very severely in a row of houses a little way from the main part of the town. It had visited every house in the row but one. The refuse which overflowed from the privies and a pigsty could be seen running into the well over the surface of the ground, and the water was very fetid; yet it was used by the people in all the houses except that which had escaped cholera. That house was inhabited by a woman who took linen to wash, and she, finding that the water gave the linen an offensive smell, paid a person to fetch water for her from the pump in the town, and this water she used for culinary purposes, as well as for washing.

The following circumstance was related to me, at the time it occurred, by a gentleman well acquainted with all the particulars. The drainage from the cesspools found its way into the well attached to some houses at Locksbrook, near Bath, and the cholera making its appearance there in the autumn of 1849, became very fatal. The people complained of the water to the gentleman belonging to the property, who lived at Weston, in Bath, and he sent a surveyor, who reported that nothing was the matter. The tenants still complaining, the owner went himself, and on looking at the water and smelling it, he said that he could perceive nothing the matter with it. He was asked if he would taste it, and he drank a glass of it. This occurred on a Wednesday; he went home, was taken ill with the cholera, and died on the Saturday following, there being no cholera in his own neighbourbood at the time.

There is no spot in this country in which the cholera was more fatal during the epidemic of 1832 than the village of Newburn, near Newcastle-upon-Tyne. We are informed, in an excellent paper on the subject by Dr. David Craigie,[7] that exactly one-tenth of the population died. The number of the inhabitants was five hundred and fifty; of these, three hundred and twenty suffered from the epidemic, either in the form of diarrhoea or the more confirmed disease, and the deaths amounted to fifty-five. Being aware of this mortality, I wrote, about the beginning of the year 1849, to a friend in Newcastle—Dr. Embleton—to make inquiries respecting the water used at Newburn, and he kindly procured me some information from the Rev. John Reed, of Newburn Vicarage, which I received in February, as well as an answer written in the meantime. I learnt from these communications that the people were supplied with water in 1832, as they still were, from three wells, two of which were very little used, and that the water in the third well was derived from the workings of an old coal-mine near the village. The water of this well, as I was informed, although generally good when first drawn, became putrid after being kept two days. It was considered that the evacuations of the people could not get into any of the wells; but the vicar thought that the water of a little brook which runs past the village, and falls into the Tyne immediately afterwards, might find its way into that well which is chiefly resorted to. Putrefaction, on being kept a day or two, is so much the character of water containing animal matter, that, after receiving confirmation of my views respecting the communication of cholera by water from many other places, I wrote to Mr. Davison again on the subject, and he kindly took a great deal of trouble to investigate the matter further. He informed me that the brook was principally formed by water which was constantly pumped from coal-pits in the neighbourhood. About half a mile before reaching Newburn it received the refuse of a small village, and between that village and Newburn it ran through a privy used by the workmen of a steel factory. In Newburn this brook received the contents of the open drains or gutters from the houses. The drain which conveyed water from a coal mine or drift not worked for a great number of years, to the well mentioned above, passed underneath the brook at one part of its course, and from that point ran alongside of the brook to the well,—a distance of about three hundred yards. Mr. Davison said that it was disputed whether there was any communication between the drain and the brook, but that it was highly probable that there might be; and that an occurrence which took place a few months previously seemed to prove that there was. Some gas-water from the steel manufactory mentioned above got by accident into the brook, and some of the people affirmed that the water in the well was strongly impregnated with it.

The first case of cholera in Newburn was that of a young man living close to the brook, about a hundred yards above the place at which it passes the well. He was taken ill on the 29th December, 1831, and died, in the stage of consecutive fever, on January 4th, 1832. There were some cases of diarrhoea in the village, but no new cases of cholera till the night of January the 9th, during which night and the following morning thirteen persons were taken ill. During the night of the 12th four persons were attacked; by the 15th there were fourteen new cases, and on this day the late vicar died—the Rev. John Edmonston. By the next day at noon there were at least fifty new cases. A few days after this the disease began to subside, and by the 2nd of February had almost disappeared. As several days elapsed between the first case of cholera and the great outbreak, it is probable that the water in which the soiled linen must have been washed, and which would necessarily run into the brook, was the means of communicating the disease to the thirteen persons taken ill on the night between the 9th and 10th of January; unless, indeed, the intermediate cases of diarrhoea could transmit the disease.

The following passage is from the report of Mr. Cruikshanks on the outbreak of cholera in 1814, previously alluded to as occurring in a battalion on its march from Jaulnah to Trichinopoly.

> *It was the belief of the natives, strenuously fostered and inculcated by their spiritual guides, that the epidemic was the immediate consequence of the wrath of Heaven, outraged and insulted by the pollution of certain sacred tanks, situated at the village of Cunnatore, in which sepoys*[8] *of low caste and camp followers had indiscriminately bathed. Such we may not regard as affording a very satisfactory solution of the difficulty; yet it leads, I think, directly to the true point of inquiry. At Cunnatore, the force was so encamped that while the 5th Native Infantry on the right had their supplies of water from wells, the puckallies of the 9th Native Infantry procured water for that battalion from tanks situated on low ground on the left of the line. The fact,*

that the disease first broke forth in a day or two after passing Cunnatore; the prevailing opinion of the natives, that it originated there, and that somehow it was connected with the tanks; a desire to discover some one cause confined in its influence and operation to one out of the two battalions: lastly, the difficulty or impossibility of lighting on any other; all these led to inquiry, and to ascertaining with a considerable degree of certainty, that each battalion was supplied with water from a source distinct from the other.[9]

The cholera was said not to be at Cunnatore at the time the infantry were encamped there, but this was probably a mistake.

The following quotation is from a letter by a medical officer in the Black Sea fleet, dated Baljik, August 23, 1854, and published in the *Medical Times and Gazette* of September 30th.

A week after the return of the fleet to Baljik, on the 7th of August, about four thousand French troops encamped on the heights abreast our anchorage. These were part of the first division of the army that had marched to Kostenje, about ten days before. By it the first blood had been drawn on the part of the allied army. The loss in battle was small, but they had encountered an enemy more terrible than the Russians. The cholera had broken out among them, and attacking four hundred on the first night had destroyed sixty. The total loss had been something incredible. It was said, that out of eleven thousand men, not less than five thousand had perished in a few days. This dreadful calamity was attributed to drinking water from wells that had been poisoned by, throwing in putrid carcasses.

Putting aside the question of intentional poisoning, which always presents itself as the most ready way of accounting for such destruction, perhaps some support to the theory, that water is the medium by which cholera poison is conveyed, may be found in this circumstance, and in another of which I was witness. These soldiers, wearied by marching from a focus of cholera infection, were seen, many of them, washing their persons and clothing in the stream from which all the French ships of war, and the majority of the English fleet, obtained their supply of water. This was going on on the 7th and 8th, on the nights of the 9th and 10th, the disease burst out with great violence among the crews of several ships.

Some English ships were the first to suffer, on the night of the 9th, and they proceeded to sea next morning. On the night of the 10th, other English ships, and some of the French, began to suffer; and the latter in an almost unparalleled manner.

The two admirals' ships, Montebello and Ville de Paris, were terribly affected. On the previous day they had been in as healthy a state as usual; and in the night the cholera attacked, in the former, two hundred men, of whom forty lay dead in the morning; and in the Ville de Paris there were also many *deaths. The French fleet sailed on the afternoon of the 11th; and the following morning saw the English ships also at sea.*

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On this day (the 14th), about noon, the Britannia, which had left port in a favourable condition, was attacked suddenly, and in twenty hours upwards of fifty of her crew had expired. We knew nothing of the calamity that had overwhelmed our leader until the following morning, when 'reports of the sick' were sent from each ship to the admiral. By this time (the evening of the 16th), eighty had died, and more than two hundred remained in greater or less danger.

The night of the 16th must have been one of great consternation on board her. The epidemic went on with unchecked violence; the officers were voluntarily attending on the sick; and the very few of the crew who had not been attacked, or who were not assisting their unfortunate messmates, were found quite insufficient to perform the duties of a ship when under sail; and the admiral, therefore, determined to return to Baljik, taking, with him the Trafalgar and Albion, also badly affected.

The crew of the Britannia were at once sent away from the ship, in small parties, into the numerous transports that remained idle; and it appears that, by this procedure, the epidemic influences operating among them have been greatly moderated, if not extirpated.

The most terrible outbreak of cholera which ever occurred in this kingdom, is probably that which took place in Broad Street, Golden Square, and the adjoining streets, a few weeks ago. Within two hundred and fifty yards of the spot where Cambridge Street joins Broad Street, there were upwards of five hundred fatal attacks of cholera in ten days. The mortality in this limited area probably equals any that was ever caused in this country, even by the plague; and it was much more sudden, as the greater number of cases terminated in a few hours. The mortality would undoubtedly have been much greater had it not been for the flight of the population. Persons in furnished lodgings left first, then other lodgers went away, leaving their furniture to be sent for when they could meet with a place to put it in. Many houses were closed altogether, owing to the death of the proprietors; and, in a great number of instances, the tradesmen who remained had sent away their families: so that in less than six days from the commencement of the outbreak, the most afflicted streets were deserted by more than three-quarters of their inhabitants.

There were a few cases of cholera in the neighbourhood of Broad Street, Golden Square, in the latter part of August; and the so-called outbreak, which commenced in the night between the 31st August and the 1st September was, as in all similar instances, only a violent increase of the malady. As soon as I became acquainted with the situation and extent of this irruption of cholera, I suspected some contamination of the water of the much-frequented street pump in Broad Street, near the end of Cambridge Street; but on examining the water, on the evening, of the 3rd September, I found so little impurity in it of an organic nature, that I hesitated to come to a conclusion. Further inquiry, however, showed me that there was no other circumstance or agent common to the circumscribed locality in which this sudden increase of cholera occurred, and not extending beyond it, except the water of the above mentioned pump. I found, moreover, that the water varied, during the next two days, in the amount of organic impurity, visible to the naked eye, on close inspection, in the form of small white, flocculent particles; and I concluded that, at the commencement of the outbreak, it might possibly have been still more impure. I requested permission, therefore, to take a list, at the General Register Office, of the deaths from cholera, registered during the week ending 2nd September, in the sub-districts of Golden Square, Berwick Street, and St. Ann's, Soho, which was kindly granted. Eighty-nine deaths from cholera were registered, during the week, in the three sub-districts. Of these, only six occurred in the four first days of the week; four occurred on Thursday, the 31st August; and the remaining seventy-nine on Friday and Saturday. I considered, therefore, that the outbreak commenced on the Thursday; and I made inquiry in detail, respecting the eighty-three deaths registered as having taken place during the last three days of the week.

On proceeding to the spot, I found that nearly all the deaths had taken place within a short distance of the pump. There were only ten deaths in houses situated decidedly nearer to another street pump. In five of these cases the families of the deceased persons informed me that they always sent to the pump in Broad Street, as they preferred the water to that of the pump which was nearer. In three other cases, the deceased were children who went to school near the pump in Broad Street. Two of them were known to drink the water; and the parents of the third think it probable that it did so. The other two deaths, beyond the district which this pump supplies, represent only the amount of mortality from cholera that was occurring before the irruption [*sic*] took place.

With regard to the deaths occurring in the locality belonging to the pump, there were sixty-one instances in which I was informed that the deceased persons used to drink the pump-water from Broad Street, either constantly or occasionally. In six instances I could get no information, owing to the death or departure of every one connected with the deceased individuals; and in six cases I was informed that the deceased persons did not drink the pump-water before their illness.

The result of the inquiry then was, that there had been no particular outbreak or increase of cholera, in this part of London, except among the persons who were in the habit of drinking the water of the above-mentioned pump-web.

I had an interview with the Board of Guardians of St. James's parish, on the evening of Thursday, 7th September, and represented the above circumstances to them. In consequence of what I said, the handle of the pump was removed on the following day.

Besides the eighty-three deaths mentioned above as occurring on the three last days of the week ending September 2nd, and being registered during that week in the sub-districts in which the attacks occurred, a number of persons died in Middlesex and other hospitals and a great number of deaths which took place in the locality during, the last two days of the week, were not registered till the week following. The deaths altogether, on the 1st and 2nd of September, which have been ascertained to belong to this outbreak of cholera, were one hundred and ninety-seven; and many persons who were attacked about the same time as these, died afterwards. I should have been glad to inquire respecting the use of the water from Broad Street pump in all these instances, but was engaged at the time in an inquiry in the south districts of London, which will be alluded to afterwards and when I began to make fresh inquiries in the neighbourhood of Golden Square, after two or three weeks had elapsed, I found that there had been such a distribution of the remaining population that it would be impossible to arrive at a complete account of the circumstances. There is no reason to suppose, however, that a more extended inquiry would have yielded a different result from that which was obtained respecting the eighty-three deaths which happened to be registered within the district of the outbreak before the end of the week in which it occurred.

The additional facts that I have been able to ascertain are in accordance with those above related; and as regards the small number of those attacked, who were believed not to have drank the water from Broad Street pump, it must be obvious that there are various ways in which the deceased persons may have taken it without the knowledge of their friend. The water was used for mixing with spirits in all the public houses around. It was used likewise at dining-rooms and coffee-shops. The keeper of a coffee-shop in the neighbourhood, which was frequented by mechanics, and where the pump-water was supplied at dinner time, informed me (on 6th September) that she was already aware of nine of her customers who were dead. The pump-water was also sold in various little shops, with a teaspoonful of effervescing powder in it, under the name of sherbet; and it may have been distributed in various other ways with which I am unacquainted. The pump was frequented much more than is usual, even for a London pump in a populous neighbourhood.

There are certain circumstances bearing on the subject of this outbreak of cholera which require to be mentioned. The Workhouse in Poland Street is more than three-fourths surrounded by houses in which deaths from cholera occurred, yet out of five hundred and thirty-five inmates only five died of cholera, the other deaths which took place being those of persons admitted after they were attacked. The workhouse has a pump-well on the premises, in addition to the supply from the Grand Junction Water Works, and the inmates never sent to Broad Street for water. If the mortality in the workhouse had been equal to that in the streets immediately surrounding it on three sides, upwards of one hundred persons would have died.

There is a Brewery in Broad Street, near to the pump, and on perceiving that no brewer's men were registered as having died of cholera, I called on Mr. Huggins, the proprietor. He informed me that there were above seventy workmen employed in the brewery, and that none of them had suffered from cholera,—at least in a severe form,—only two having been indisposed, and that not seriously at the time the disease prevailed. The men are allowed a certain quantity of malt liquor, and Mr. Huggins believes they do not drink water at all; and he is quite certain that the workmen never obtained water from the pump in the street. There is a deep well in the brewery, in addition to the New River water.

At the percussion-cap manufactory, 37 Broad Street, where, I understand, about two hundred work-people were employed, two tubs were kept on the premises always supplied with water from the pump in the street, for those to drink who wished; and eighteen of these workpeople died of cholera at their own homes, sixteen men and two women.

Mr. Marshall, surgeon, of Greek Street, was kind enough to inquire respecting seven workmen who had been employed in the manufactory of dentists' materials, at Nos. 8 and 9 Broad Street, and who died at their own homes. He learned that they were all in the habit of drinking water from the pump, generally drinking about half-a-pint once or twice a day while two persons who reside constantly on the premises, but do not drink the pump-water, only had diarrhoea. Mr. Marshall also informed me of the case of an officer in the army, who lived at St. John's Wood, but came to dine in Wardour Street, where he drank the water from Broad Street pump at his dinner. He was attacked with cholera, and died in a few hours.

I am indebted to Mr. Marshall for the following cases, which are interesting as showing the period of incubation, which in these three cases was from thirty-six to forty-eight hours. Mrs. —— of 13 Bentinck Street, Berwick Street, aged 28, in the eighth month of pregnancy, went herself (although they were not usually water drinkers), on Sunday, 3rd September, to Broad Street pump for water. The family removed to Gravesend on the following day; and she was attacked with cholera on Tuesday morning at seven o'clock, and died of consecutive fever on 15th September, having been delivered. Two of her children drank also of the water, and were attacked on the same day as the mother, but recovered.

Dr. Fraser, of Oakley Square, kindly informed me of the following circumstance. A gentleman in delicate health was sent for from Brighton to see his brother at 6 Poland Street, who was attacked with cholera and died in twelve hours, on 1st September. The gentleman arrived after his brother's death, and did not see the body. He only stayed about twenty minutes in the house, where he took a hasty and scanty luncheon of rump steak, taking with it a small tumbler of brandy and water, the water being from Broad Street pump. He went to Pentonville, and was attacked with cholera on the evening of the following day, 2nd September, and died the next evening.

Dr. Fraser also first called my attention to the following circumstances, which are perhaps the most conclusive of all in proving the connexion [*sic*] between the Broad Street pump and the outbreak of cholera. In the "Weekly Return of Births and Deaths" of September 9th, the following death is recorded as occurring in the Hampstead district: "At West End, on 2nd September, the widow of a percussion-cap maker, aged 59 years, diarrhoea two hours, cholera epidemics sixteen hours."

I was informed by this lady's son that she had not been in the neighbourhood of Broad Street for many months. A cart went from Broad Street to West End every day, and it was the custom to take out a large bottle of the water from the pump in Broad Street, as she preferred it. The water was taken on Thursday, 31st August, and she drank of it in the evening, and also on Friday. She was seized with cholera on the evening of the latter day, and died on Saturday, as the above quotation from the register shows. A niece, who was on a visit to this lady, also drank of the water; she returned to her residence, in a high and healthy part of Islington, was attacked with cholera, and died also. There was no cholera at the time, either at West End or in the neighbourhood where the niece died. Besides these two persons, only one servant partook of the water at Hampstead West End, and she did not suffer, or, at least, not severely. There were many persons who drank the water from Broad Street pump about the time of the outbreak, without being attacked with cholera; but this does not diminish the evidence respecting the influence of the water, for reasons that be fully stated in another part of this work.

The deaths which occurred during this fatal outbreak of cholera are indicated in the accompanying map, as far as I could ascertain them [not included. Ed.]. There are necessarily some deficiencies, for in a few of the instances of persons who died in the hospitals after their removal from the neighbourhood of Broad Street, the number of the house from which they had been removed was not registered. The address of those who died after their removal to St. James's Workhouse was not registered; and I was only able to obtain it, in a part of the cases, on application at the Master's Office, for many of the persons were too ill, when admitted, to give any account of themselves. In the case also of some of the workpeople and others who contracted the cholera in this neighbourhood, and died in different parts of London, the precise house from which they had removed is not stated in the return of deaths. I have heard of some persons who died in the country shortly after removing from the neighbourhood of Broad Street; and there must, no doubt, be several cases of this kind that I have not heard of. Indeed, the full extent of the calamity will probably never be known. The deficiencies I have mentioned, however, probably do not detract from the correctness of the map as a diagram of the topography of the outbreak; for, if the locality of the few additional cases could be ascertained, they would probably be distributed over the district of the outbreak in the same proportion as the large number which are known.

The dotted line on the map surrounds the sub-districts of Golden Square, St. James's, and Berwick Street, St. James's, together with the adjoining portion of the sub-district of St. Anne, Soho, extending from Wardour Street to Dean Street, and a small part of the sub-district of St. James's Square enclosed by Marylebone Street, Titchfield Street, Great Windmill Street, and Brewer Street. All the deaths from cholera which were registered in the six weeks from 19th August to 30th September within this locality, as well as those of persons removed into Middlesex Hospital, are shown in the map[10] by a black line in the situation of the house in which it occurred, or in which the fatal attack was contracted.

In addition to these the deaths of persons removed to University College Hospital, to Charing Cross Hospital, and to various parts of London, are indicated in the map, where the exact address was given in the "Weekly Return of Deaths," or, when I could learn it by private inquiry.

The pump in Broad Street is indicated on the map, as well as all the surrounding pumps to which the public had access at the time. It requires to be stated that the water of the pump in Marlborough Street, at the end of Carnaby Street, was so impure that many people avoided using it. And I found that the persons who died near this pump in the beginning of September, had water from the Broad Street pump. With regard to the pump in Rupert Street, it will be noticed that some streets which are near to it on the map, are in fact a good way removed, on account of the circuitous road to it. These circumstances being taken into account, it will be observed that the deaths either very much diminished, or ceased altogether, at every point where it becomes decidedly nearer to send to another pump than to the one in Broad Street. It may also be noticed that the deaths are most numerous near to the pump where the water could be more readily obtained. The wide open street in which the pump is situated suffered most, and next the streets branching from it, and especially those parts of them which are nearest to Broad Street. If there have been fewer deaths in the south half of Poland Street than in some other streets leading from Broad Street, it is no doubt because this street is less densely inhabited.

In some of the instances, where the deaths are scattered a little further from the rest on the map, the malady was probably contracted at a nearer point to the pump. A cabinet-maker, who was removed from Philip's Court, Noel Street, to Middlesex Hospital, worked in Broad Street. A boy also who died in Noel Street, went to the National school at the end of Broad Street, and having to pass the pump, probably drank of the water. A tailor, who died at 6, Heddon Court, Regent Street, spent most of his time in Broad Street. A woman, removed to the hospital from 10, Heddon Court, had been nursing a person who died of cholera in Marshall Street. A little girl, who died in Ham Yard, and another who died in Angel Court, Great Windmill Street, went to the school in Dufour's Place, Broad Street, and were in the habit of drinking, the pump-water, as were also a child from Naylor's Yard, and several others who went to this and other schools near the pump in Broad Street. A woman who died at 2, Great Chapel Street, Oxford Street, had been occupied for two days preceding her illness at the public washhouses near the pump, and used to drink a good deal of water whilst at her work; the water drank there being sometimes from the pump and sometimes from the cistern.

The limited district in which this outbreak of cholera occurred, contains a great variety in the quality of the streets and houses; Poland Street and Great Pulteney Street consisting in a great measure of private houses occupied by one family, whilst Husband Street and Peter Street are occupied chiefly by the poor Irish. The remaining streets are intermediate in point of respectability. The mortality appears to have fallen pretty equally amongst all classes, in proportion to their numbers. Masters are not distinguished from journeymen in the registration returns of this district, but, judging from my own observation, I consider that out of rather more than six hundred deaths, there were about one hundred in the families of tradesmen and other resident householders. One hundred and five persons who had been removed from this district died in Middlesex, University College, and other hospitals, and two hundred and six persons were buried at the expense of St. James's parish; the latter number includes many of those who died in the hospitals, and a great number who were far from being paupers, and would on any other occasion have been buried by their friends, who, at this time, were either not aware of the calamity or were themselves overwhelmed by it. The greatest portion of the persons who died were tailors and other operatives, who worked for the shops about Bond Street and Regent Street, and the wives and children of these operatives. They were living chiefly in rooms which they rented by the week.

The following table exhibits the chronological features of this terrible outbreak of cholera.

The deaths in Table I are compiled from the sources mentioned above in describing the map; but some deaths which were omitted from the map on account of the number of the house not being known, are included in the table. As regards the date of attack, I was able to obtain it with great precision, through the kindness of Mr. Sibley, in upwards of eighty deaths which occurred in Middlesex Hospital; for the hour of admission was entered in the hospital books, as well as the previous duration of the illness. In a few other cases also I had exact information of the hour of attack, and in the remainder I have calculated it by subtracting the duration of the illness from the date of death. Where the illness did not exceed twelve hours, the attack was considered to have commenced the same day; where the illness exceeded twelve, and did not exceed thirty-six hours, the attack was put down to the previous day, and so on. Where the illness exceeded forty-eight hours, its duration is generally given in days, which were subtracted from the date of the attack. Although this plan does not always give the precise date of attack, it reaches within a few hours of it, and is as valuable perhaps as if the exact day were given, unless the hour as well as the day could be introduced into the table. Where premonitory diarrhoea is stated to have existed, the period of its duration is deducted from the date of death, and, in fact, the time of attack is fixed at the first commencement of indisposition, except in two or three instances in which the patient was labouring under another disease, as phthisis or typhus fever. There are forty-five cases in which the duration of the illness was not certified, or entered in the books of the registrars, and the time of attack in these cases is consequently unknown. These persons nearly all died in the first days of September, in the height of the calamity, and it is almost certain that they were cut off very quickly, like the others who died at this time.

It is pretty certain that very few of the fifty-six attacks placed in the table to the 31st August occurred till late in the evening, of that day. The irruption was extremely sudden, as I learn from the medical men living in the midst of the district, and commenced in the night between the 31st August and 1st September. There was hardly any premonitory diarrhoea in the cases which occurred during the first three days of the outbreak and I have been informed by several medical men, that very few of the cases which they attended on those days ended in recovery.

The greatest number of attacks in any one day occurred on the 1st of September, immediately after the outbreak commenced. The following day the attacks fell from one hundred and forty-three to one hundred and sixteen, and the day afterwards to fifty-four. A glance at the above table will show that the fresh attacks continued to become less numerous every day. On September the 8th—the day when the handle of the pump was removed—there were twelve attacks; on the 9th, eleven; on the 10th, five; on the 11th, five; on the 12th, only one; and after this time, there were never more than four attacks on one day. During the decline of the epidemic the deaths were more numerous than the attacks, owing to the decease of many persons who had lingered for several days in consecutive fever.

Table I

Date	No. of Fatal Attacks	Deaths
August 19	1	1
" 20	1	0
" 21	1	2
" 22	0	0
" 23	1	0
" 24	1	2
" 25	0	0
" 26	1	0
" 27	1	1
" 28	1	0
" 29	1	1
" 30	8	2
" 31	56	3
Sept. 1	143	70
" 2	116	127
" 3	54	76
" 4	46	71
" 5	36	45
" 6	20	37
" 7	28	32
" 8	12	30
" 9	11	24
" 10	5	18
" 11	5	15
" 12	1	6
" 13	3	13
" 14	0	6
" 15	1	8

(*continued*)

Table I (*continued*)

Date	No. of Fatal Attacks	Deaths
" 16	4	6
" 17	2	5
" 18	3	2
" 19	0	3
" 20	0	0
" 21	2	0
" 22	1	2
" 23	1	3
" 24	1	0
" 25	1	0
" 26	1	2
" 27	1	0
" 28	0	2
" 29	0	1
" 30	0	0
Date unknown	45	0
Total	616	616

There is no doubt that the mortality was much diminished, as I said before, by the flight of the population, which commenced soon after the outbreak but the attacks had so far diminished before the use of the water was stopped, that it is impossible to decide whether the well still contained the cholera poison in an active state, or whether, from some cause, the water had become free from it. The pump-well has been opened, and I was informed by Mr. Farrell, the superintendent of the works, that there was no hole or crevice in the brickwork of the well, by which any impurity might enter; consequently in this respect the contamination of the water is not made out by the kind of physical evidence detailed in some of the instances previously related. I understand that the well is from twenty-eight to thirty feet in depth, and goes through the gravel to the surface of the clay beneath. The sewer, which passes within a few yards of the well is twenty-two feet below the surface. The water at the time of the cholera contained impurities of an organic nature, in the form of minute whitish flocculi visible on close inspection to the naked eve, as I before stated. Dr. Hassall, who was good enough to examine some of this water with the microscope, informed me that these particles had no organized structure, and that he thought they probably resulted from decomposition of other matter. He found a great number of very minute oval animalcules in the water, which are of no importance, except as an additional proof that the water contained organic matter on which they lived. The water also contained a large quantity of chlorides, indicating, no doubt, the impure sources from which the spring is supplied. Mr. Eley, the percussion-cap manufacturer of 37 Broad Street, informed me that he had long noticed that the water became offensive, both to the smell and taste, after it had been kept about two days. This, as I noticed before, is a character of water contaminated with sewage. Another person had noticed for months that a film formed on the surface of the water when it had been kept a few hours.

I inquired of many persons whether they had observed any change in the character of the water, about the time of the outbreak of cholera, and was answered in the negative. I afterwards, however, met with the following important information on this point. Mr. Gould, the eminent ornithologist, lives near the pump in Broad Street, and was in the habit of drinking the water. He was out of town at the commencement of the outbreak of cholera, but came home on Saturday morning, 2nd September, and sent for some of the water almost immediately when he was much surprised to find that it had an offensive smell, although perfectly transparent and fresh from the pump. He did not drink any of it. Mr. Gould's assistant, Mr. Prince, had his attention drawn to the water, and perceived its offensive smell. A servant of Mr. Gould who drank the pump water daily, and drank a good deal of it on August 31st, was seized with cholera at an early hour on September 1st. She ultimately recovered.

Whether the impurities of the water were derived from the sewers, the drains, or the cesspools, of which latter there are a number in the neighbourhood, I cannot tell. I have been informed by an eminent engineer, that whilst a cesspool in a clay soil requires to be emptied every six or eight months, one sunk in the gravel will often go for twenty years without being emptied, owing to the soluble matters passing away into the land-springs by percolation. As there had been deaths from cholera just before the great outbreak not far from this pump-well, and in a situation elevated a few feet above it, the evacuations from the patients might of course be amongst the impurities finding their way into the water, and judging the matter by the light derived from other facts and considerations previously detailed, we must conclude that such was the case. A very important point in respect to this pump-well is that the water passed with almost everybody as being perfectly pure, and it did in fact contain a less quantity of impurity than the water of some other pumps in the same parish, which had no share in the propagation of cholera. We must conclude from this outbreak that the quantity of morbid matter which is sufficient to produce cholera is inconceivably small, and that the shallow pump-wells in a town cannot be looked on with too much suspicion, whatever their local reputation may be.

Whilst the presumed contamination of the water of the Broad Street pump with the evacuations of cholera patients affords an exact explanation of the fearful outbreak of cholera in St. James's parish, there is no other circumstance which offers any explanation at all, whatever hypothesis of the nature and cause of the malady be adopted. Many persons were inclined to attribute the severity of the malady in this locality to the very circumstance to which some people attribute the comparative immunity of the city of London from the same disease, *viz.,* to the drains in the neighbourhood having been disturbed and put in order about half a year previously. Mr. Bazelgette, however, pointed out, in a report to the commissioners, that the streets in which the new sewers had been made suffered less than the others; and a reference to the map will show that this is correct, for I recollect that the streets in which the sewers were repaired about February, last, were Brewer Street, Little Pulteney Street, and Dean Street, Soho. Many of the non-medical public were disposed to attribute the outbreak of cholera to the supposed existence of a pit in which persons dying of the plaque had been buried about two centuries ago; and, if the alleged plague-pit had been nearer to Broad Street, they would no doubt still cling to the idea. The situation of the supposed pit is, however, said to be Little Marlborough Street, just out of the area in which the chief mortality occurred. With regard to effluvia from the sewers passing, into the streets and houses, that is a fault common to most parts of London and other towns. There is nothing peculiar in the sewers or drainage of the limited spot in which this outbreak occurred and Saffron Hill and other localities, which suffer much more from ill odours, have been very lightly visited by cholera.

Just at the time when the great outbreak of cholera occurred in the neighbourhood of Broad Street, Golden Square, there was an equally violent irruption in Deptford, but of a more limited extent. About ninety deaths took place in a few days, amongst two or three score of small houses, in the north end of New Street and an adjoining row called French's Fields. Deptford is supplied with very good water from the river Ravensbourne by the Kent Water Works, and until this outbreak there was but little cholera in the town, except amongst some poor people, who had no water except what they got by pailsful from Deptford Creek—an inlet of the Thames. There had, however, been a few cases in and near New Street, just before the great outbreak. On going to the spot on September 12th and making inquiry, I found that the houses in which the deaths had occurred were supplied by the Kent Water Works, and the inhabitants never used any other water. The people informed me, however, that for some few weeks the water had been extremely offensive when first turned on; they said it smelt like a cesspool, and frothed like soap suds. They were in the habit of throwing away a few pailsful of that which first came in, and collecting some for use after it became clear. On inquiring in the surrounding streets, to which this outbreak of cholera did not extend, *viz.*, Wellington Street, Old Kino, Street, and Hughes's Fields, I found that there had been no alteration in the water. I concluded, therefore, that a leakage had taken place into the pipes supplying the places where the outbreak occurred, during the intervals when the water was not turned on. Gas is known to get into the water-pipes occasionally in this manner, when they are partially empty, and to impart its taste to the water. There are no sewers in New Street or French's Fields, and the refuse of all kinds consequently saturates the ground in which the pipes are laid. I found that the water collected by the people, after throwing away the first portion, still contained more organic matter than that supplied to the adjoining streets. On adding nitrate of silver and exposing the specimens to the light, a deeper tint of brown was developed in the former than in the latter.

All the instances of communication of cholera through the medium of water, above related, have resulted from the contamination of a pump-well, or some other limited supply of water; and the outbreaks of cholera connected with the contamination, though sudden and intense, have been limited also; but when the water of a river becomes infected with the cholera evacuations emptied from on board ship, or passing down drains and sewers, the communication of the disease, though generally less sudden and violent, is much more widely extended; more especially when the river water is distributed by the steam engine and pipes connected with water-works. Cholera may linger in the courts and alleys crowded with the poor, for reasons previously pointed out, but I know of no instance in which it has been generally spread through a town or neighbourhood, amongst all classes of the community, in which the drinking water has not been the medium of its diffusion. Each epidemic of cholera in London has borne a strict relation to the nature of water-supply of its different districts, being, modified only by poverty and the crowding, and want of cleanliness which always attend it.

The following table shows the number of deaths from cholera in the various districts of London in 1832, together with the nature of the water supply it that period (see next page).[11]

This table shows that in the greater part of Southwark, which was supplied with worse water than any other part of the metropolis, the mortality from cholera was also much higher than anywhere else. The other south districts, supplied with water obtained at points higher up the Thames, and containing consequently less impurity, were less affected. On the north of the Thames, the east districts, supplied, in 1832, with water from the river Lea, at Old Ford, where it contained the sewage of a large population, suffered more than other parts on the north side of London. Whitechapel suffered more than the other east districts; probably not more from the poverty and crowded state of the population, than from the great number of mariners, coal-heavers, and others, living there, who were employed on the Thames, and got their water, whilst at work, direct from the river. There were one hundred and thirty-nine deaths from cholera amongst persons afloat on the Thames. The cholera passed very lightly over most of the districts supplied by the New River Company. St Giles' was an exception, owing to the overcrowding of the common lodging-houses in the part of the parish called the Rookery. The City of London also suffered severely in 1832. Now when the engine at Broken Wharf was employed to draw water from the Thames, this water was supplied more particularly to the City, and not at all to the higher districts supplied by the New River Company. This would offer an explanation of the high mortality from cholera in the City at that time, supposing the engine were actually used during 1832; but I have not yet been able to ascertain that circumstance with certainty. I know, however, that it was still used occasionally some years later.

Westminster suffered more in 1832 than St. George, Hanover Square, and Kensington, which at that time had the same water. This arose from the poor and crowded state of part of its population. The number of cases of cholera communicated by the water would be the same in one district as in the other; but in one district the disease would spread also from person to person more than in the others.

Between 1832 and 1849 many changes took place in the water-supply of London. The Southwark Water Company united with the South London Water Company, to form a new Company under the name of the Southwark and Vauxhall Company. The water works at London Bridge were abolished, and the united company derived their supply from the Thames at Battersea Fields, about half-a-mile above Vauxhall Bridge. The Lambeth Water Company continued to obtain their supply opposite to Hungerford Market; but they had established a small reservoir at Brixton. But whilst these changes had been made by the water companies, changes still greater had taken place in the river, partly from the increase of population, but much more from the abolition of cesspools and the almost universal adoption of waterclosets in their stead. The Thames in 1849 was more impure at Battersea Fields than it had been in 1832 at London Bridge. A clause which prevented the South London Water Company from laying their pipes within two miles of the Lambeth Water Works was repealed in 1834, and the two Companies were in active competition for many years, the result of which is, that the pipes of the Lambeth Water Company and those of the Southwark and Vauxhall Company pass together down all the streets of several of the south districts. As the water of both these Companies was nearly equal in its impurity in 1849, this circumstance was of but little consequence at that time; but it will be shown further on that it afterwards led to very important results.

On the north side of the Thames the Water Companies and their districts remained the same, but some alterations were made in the sources of supply. The East London Water Company ceased to obtain water at Old Ford, and got it from the river Lea, above Lea Bridge, out of the influence of the tide and free from sewage, except that from some part of Upper Clapton. The Grand Junction Company removed their works from Chelsea to Brentford, where they formed large settling reservoirs. The New River Company entirely ceased to employ the steam-engine for obtaining water from the Thames. The supply of the other Water Companies remained the same as in 1832. The accompanying table (No. 3), shows the mortality from cholera in the various registration districts of London in 1849, together with the water supply. The annual value of house and shop-room for each person is also shown, as a criterion, to a great extent, of the state of overcrowding or the reverse. The deaths from cholera and the value of house-room, are taken from the "Report on the Cholera of 1849," by Dr. Farr, of the General Register Office. The water supply is indicated merely by the name of the Companies. After the explanation given above of the source of supply, this will be sufficient. It is only necessary to add, that the Kent Water Company derive [*sic*] their supply from the river Ravensbourne, and the Hampstead Company from springs and reservoirs at Hampstead.

A glance at the table shows that in every district to which the supply of the Southwark and Vauxhall, or the Lambeth Water Company extends, the cholera was more fatal than in any other district whatever. The only other water company deriving a supply from the Thames, in a situation where it is much contaminated with the contents of the sewers, was the Chelsea Company. But this company, which supplies some of the most fashionable parts of London, took great pains to filter the water before its distribution, and in so doing no doubt separated, amongst other matters, the greater portion of that which causes cholera. On the other hand, although the Southwark and Vauxhall and the Lambeth Water Companies professed to filter the water, they supplied it in a most impure condition. Even in the following year, when Dr. Hassall made an examination of it, he found in it the hairs of animals and numerous substances which had passed through the alimentary canal. Speaking of the water supply of London generally, Dr. Hassall says:—

> *It will be observed, that the water of the companies on the Surrey side of London, viz., the Southwark, Vauxhall, and Lambeth, is by far the worst of all those who take their supply from the Thames.*[12]

Table II

Districts	Population	Deaths from Cholera	Deaths from Cholera in 10,000 living	Water Supply
St. George the Martyr, Southwark St. Olave's, Southwark St. Saviour's, Southwark	777,796	856	110	Southwark Water Works, from Thames at London Bridge. No filter or settling reservoir.
Christchurch, Southwark	13,705	35	25	Chiefly by Lambeth Water Works, from Thames opposite Hungerford Market. No filter or settling reservoir.
Lambeth	87,856	337	38	
Newington	44,526	200	45	Chiefly by South London Water Works, from Thames at Vauxhall Bridge. Reservoirs. No filter.
Camberwell	28,231	107	37	
Bermondsey	29,741	210	70	South London Water Works, and Tidal Ditches.
Rotherhithe	12,875	19	14	
Bethnal Green	62,018	170	27	East London Water Works, from tidal part of river Lea at Old Ford.
St. George-in-the-East	38,505	123	31	
Poplar	25,066	107	42	
Stepney	78,826	225	28	
Whitechapel*	52,848	470	88	
Clerkenwell	47,634	65	13	New River Company, from various springs, and river Lea in Hertfordshire; and occasionally from Thames at Broken Wharf, near Blackfriar's Bridge.
St. Giles	52,907	280	52	
Holborn	27,334	46	16	
Islington	37,316	39	10	
London City	55,798	359	64	
East and West London	No return	—	—	
St. Luke's	46,642	118	25	
Strand	9,937	37	37	
Hackney	7,326	8	10	New River and East London Water Companies.
Shoreditch	68,564	57	8	
Westminster	124,585	325	26	Chelsea Water Works, from Thames at Chelsea. Reservoir and filters.

Districts	Population	Deaths from Cholera	Deaths from Cholera in 10,000 living	Water Supply
St. George, Hanover Square	58,209	74	12	Chelsea Water Works and Grand Junction Water Works, also supplying water from Thames at Chelsea, and having settling reservoirs.
Kensington	75,130	134	17	
St. Marylebone	122,206	224	20	West Middlesex Water Works, from Thames at Hammersmith. Settling reservoirs.
St. Pancras	103,548	111	10	West Middlesex, New River, and Hampstead Water Works.
*A small part of the Whitechapel District is supplied with New River water.				

In the north districts of London, which suffered much less from cholera than the south districts, the mortality was chiefly influenced by the poverty and crowding of the population. The New River Company having entirely left off the use of their engine in the city, their water, being entirely free from sewage, could have had no share in the propagation of cholera. It is probable also, that the water of the East London Company, obtained above Lea Bridge, had no share in propagating, the malady; and that this is true also of the West Middlesex Company, obtaining their supply from the Thames at Hammersmith and of the Grand Junction Company, obtaining, their supply at Brentford. All these Water Companies have large settling reservoirs. It is probable also, as I stated above, that the Chelsea Company in 1849, by careful filtration and by detaining the water in their reservoirs, rendered it in a great degree innocuous.

Some parts of London suffered by the contamination of the pump-wells in 1849, and the cholera in the districts near the river was increased by the practice, amongst those who are occupied on the Thames, of obtaining water to drink by dipping a pail into it. It will be shown further on, that persons occupied on the river suffered more from cholera than others. Dr. Baly makes the following inquiry in his Report to the College of Physicians.[13]

Table III Showing the Mortality from Cholera, and the Water Supply, in the Districts of London, in 1849. The Districts are arranged in the order of their Mortality from Cholera.

District	Population Middle of 1849	Deaths from Cholera	Deaths by Cholera to 10,000-inhabitants	Annual value of House & Shop room to each person in £	Water Supply
Rotherhithe	17,208	352	205	4.238	Southwark and Vauxhall Water Works, Kent Water Works, and Tidal Ditches.
St. Olave, Southwark	19,278	349	181	4.559	Southwark and Vauxhall.
St. George, Southwark	50,900	836	164	3.518	Southwark and Vauxhall, Lambeth.
Bermondsey	45,500	734	161	3.077	Southwark and Vauxhall.
St. Saviour, Southwark	35,227	539	153	5.291	Southwark and Vauxhall.
Newington	63,074	907	144	3.788	Southwark and Vauxhall, Lambeth.
Lambeth	134,768	1618	120	4.389	Southwark and Vauxhall, Lambeth.
Wandsworth	48,446	484	100	4.839	Pump-wells, Southwark, and Vauxhall, river Wandle.
Camberwell	51,714	504	97	4.508	Southwark and Vauxhall, Lambeth.
West London	28,829	429	96	7.454	New River.
Bethnal Green	87,263	789	90	1.480	East London.
Shoreditch	104,122	789	76	3.103	New River, East London.
Greenwich	95,954	718	75	3.379	Kent.
Poplar	44,103	313	71	7.360	East London.
Westminster	64,109	437	68	4.189	Chelsea.
Whitechapel	78,590	506	64	3.388	East London.
St. Giles	54,062	285	53	5.635	New River.
Stepney	106,988	501	47	3.319	East London.
Chelsea	53,379	247	46	4.210	Chelsea.

District	Population Middle of 1849	Deaths from Cholera	Deaths by Cholera to 10,000-inhabitants	Annual value of House & Shop room to each person in £	Water Supply
East London	43,495	182	45	4.823	New River.
St. George's, East	47,334	199	42	4.753	East London.
London City	55,816	207	38	17,676	New River.
St. Martin	24,557	91	37	11,844	New River.
Strand	44,254	156	35	7.374	New River.
Holborn	46,134	161	35	5.883	New River.
St. Luke	53,234	183	34	3.731	New River.
Kensington (except Paddington)	110,491	260	33	4.824	West Middlesex, Chelsea, Grand Junction.
Lewisham	32,299	96	30	5.070	Kent.
Belgrave	37,918	105	28	8.875	Chelsea.
Hackney	55,152	139	25	4.397	New River, East London.
Islington	87,761	187	22	5.494	New River.
St. Pancras	160,122	360	22	4.871	New River, Hampstead, West Middlesex.
Clerkenwell	63,499	121	19	4.138	New River.
Marleybone	153,960	261	17	7.586	West Middlesex.
St. James, Westminster	36,426	57	16	12.669	Grand Junction, New River.
Paddington	41,267	35	8	9.349	Grand Junction.
Hampstead	11,572	9	8	5.804	Hampstead, West Middlesex.
Hanover Square & May Fair	33,196	26	8	16.754	Grand Junction.
London	2,280,282	14,137	62	—	

> *How did it happen, if the character of the water has a great influence on the mortality from cholera, that in the Belgrave district only 28 persons in 10,000 died, and in the Westminster district, also supplied by the Chelsea Company, 68 persons in 10,000; and, again, that in the Wandsworth district the mortality was only 100, and in the district of St. Olave 181 in 10,000 inhabitants—both these districts receiving their supply from the Southwark Company?*

The water of the Chelsea Company has been alluded to above, but whether this water had any share in the propagation of cholera or not, it is perfectly in accordance with the mode of communication of the disease which I am advocating, that it should spread more in the crowded habitations of the poor, in Westminster, than in the commodious houses of the Belgrave district. In examining the effect of polluted water as a medium of the cholera poison, it is necessary to bear constantly in mind the more direct way in which the poison is also swallowed, as I explained in the commencement of this work. As regards St. Olave's and Wandsworth, Dr. Baly was apparently not aware that, whilst almost every house in the first of these districts is supplied by the water company, and has no other supply, the pipes of the company extend to only a part of the Wandsworth district, a large part of it having only pump-wells.

The epidemic of 1849 was a continuance or revival of that which commenced in the autumn of 1848, and there are some circumstances connected with the first cases which are very remarkable, and well worthy of notice. It has been already stated (page 3) that the first case of decided Asiatic cholera in London, in the autumn of 1848, was that of a seaman from Hamburgh, and that the next case occurred in the very room in which the first patient died. These cases occurred in Horsleydown, close to the Thames. In the evening of the day on which the second case occurred in Horsleydown, a man was taken ill in Lower Fore Street, Lambeth, and died on the following morning. At the same time that this case occurred in Lambeth, the first of a series of cases occurred in White Hart Court, Duke Street, Chelsea, near the river. A day or two afterwards, there was a case at 3, Harp Court, Fleet Street. The next case occurred on October 2nd, on board the hulk *Justitia*, lying off Woolwich; and the next to this in Lower Fore Street, Lambeth, three doors from where a previous case had occurred. The first thirteen cases were all situated in the localities just mentioned; and on October 5th there were two cases in Spitalfields.

Now, the people in Lower Fore Street, Lambeth, obtained their water by dipping a pail into the Thames, there being no other supply in the street. In White Hart Court, Chelsea, the inhabitants obtained water for all purposes in a similar way. A well was afterwards sunk in the court; but at the time these cases occurred the people had no other means of obtaining water, as I ascertained by inquiry on the spot. The inhabitants of Harp

Court, Fleet Street, were in the habit, at that time, of procuring water from St. Bride's pump, which was afterwards closed on the representation of Mr. Hutchinson, surgeon, of Farringdon Street, in consequence of its having, been found that the well had a communication with the Fleet Ditch sewer, up which the tide flows from the Thames. I was informed by Mr. Dabbs, that the hulk *Justitia* was supplied with spring water from the Woolwich Arsenal; but it is not improbable that water was occasionally taken from the Thames alongside, as was constantly the practice in some of the other hulks, and amongst the shipping generally.

When the epidemic revived again in the summer of 1849, the first case in the sub-district "Lambeth; Church, 1st part," was in Lower Fore Street, on June 27th; and on the commencement of the epidemic of the present year, the first case of cholera in any part of Lambeth, and one of the earliest in London, occurred at 52, Upper Fore Street, where also the people had no water except what they obtained from the Thames with a pail, as I ascertained by calling at the house. Many of the earlier cases this year occurred in persons employed amongst the shipping in the river, and the earliest cases in Wandsworth and Battersea have generally been amongst persons getting water direct from the Thames, or from streams up which the Thames flows with the tide. It is quite in accordance with what might be expected from the propagation of cholera through the medium of the Thames water, that it should generally affect those who draw it directly from the river somewhat sooner than those who receive it by the more circuitous route of the pipes of a water company.

London was without cholera from the latter part of 1849 to August 1853. During this interval an important change had taken place in the water supply of several of the south districts of London. The Lambeth Company removed their water works, in 1852, from opposite Hungerford Market to Thames Ditton; thus obtaining a supply of water quite free from the sewage of London. The districts supplied by the Lambeth Company are, however, also supplied, to a certain extent, by the Southwark and Vauxhall Company, the pipes of both companies going down every street, in the places where the supply is mixed, as was previously stated. In consequence of this intermixing of the water supply, the effect of the alteration made by the Lambeth Company on the progress of cholera was not so evident, to a cursory observer, as it would otherwise have been. It attracted the attention however, of the Registrar General, who published a table in the "Weekly Return of Births and Deaths" for 26th November 1853, of which Table IV (see next page) is an abstract containing as much as applies to the south districts of London.

It thus appears that the districts partially supplied with the improved water suffered much less than the others, although, in 1849, when the Lambeth Company obtained their supply opposite Hungerford Market, these same districts suffered quite as much as those supplied entirely by the

Table IV

Water Companies	Sources of Supply	Aggregate of Districts supplied chiefly by the respective Companies		Deaths in 100,000 inhabitants
		Population	Deaths by Cholera in 13 wks. ending Nov. 19	
(1) Lambeth and (2) Southwark and Vauxhall	Thames, at Thames Ditton and at Battersea	346,363	211	61
Southwark and Vauxhall	Thames, at Battersea	118,267	111	94
(1) Southwark and Vauxhall (2) Kent	Thames, at Battersea: the Ravensbourne, in Kent, & ditches and wells	17,805	19	107

Southwark and Vauxhall Company, as was shown in Table III. The Lambeth water extends to only a small portion of some of the districts necessarily included in the groups supplied by both Companies; and when the division is made a little more in detail, by taking sub-districts instead of districts, the effect of the new water supply is shown to be greater than appears in the above table. The Kent Water Company was introduced into the table by the Registrar-General on account of its supplying a small part of Rotherhithe. The following interesting remarks appeared, respecting this portion of Rotherhithe, in the "Weekly Return" of December 10, 1853:—

London Water Supply.—The following is an extract from a letter which the Register-General has received from Mr. Pitt, the Registrar of Rotherhithe:—

> *I consider Mr. Morris's description of the part of the parish through which the pipes of the Kent Water Company were laid in 1849, is in the main correct; for though the Company had entered the parish, the water was but partially taken by the inhabitants up to the time of the fearful visitation in the above year.*
>
> *With respect to the deaths in 1849, they were certainly more numerous in the district now generally, supplied by the Kent Company than in any other part of the parish. I only need mention Charlotte Row, Ram Alley, and Silver Street,—places where the scourge fell with tremendous severity.*
>
> *Among the recent cases of cholera, not one has occurred in the district supplied by the Kent Water Company.*

The parish of Rotherhithe has been badly supplied with water for many ages past. The people drank from old wells, old pumps, open ditches, and the muddy stream of the Thames.

In 1848–9 the mortality from cholera in Rotherhithe was higher than it was in any other district of London. This is quite in conformity with the general rule, that when cholera prevails, it is most fatal where the waters are most impure.

The following table (which, with a little alteration in the arrangement, is taken from the "Weekly Return Of Births and Deaths" for 31st December 1853) shows the mortality from cholera, in the epidemic of 1853, down to a period when the disease had almost disappeared. The districts are arranged in the order of their mortality from Cholera.

Table V

Districts	Population in 1853 (estimated)	Deaths by Chol. In 17 wks., Aug. 21 to Dec. 17, 1853	Deaths by Cholera to 100,000 living	Water Supply
Bermondsey	48,128	73	150	Southwark & Vauxhall.
S. Saviour, Southwark	35,731	52	146	Southwark & Vauxhall, Lambeth.
S. George, Southwark	51,824	74	143	Southwark & Vauxhall, Lambeth.
St. Olave	19,375	26	134	Southwark & Vauxhall.
Rotherhithe	17,805	20	112	Southwark & Vauxhall, Kent.
Whitechapel	79,759	78	95	East London.
Newington	64,816	37	57	Southwark & Vauxhall, Lambeth.
Kensington, except Paddington	73,699	40	53	West Middlesex, Chelsea, Grand Junct.
Wandsworth	50,764	26	51	Southwark & Vauxhall, Pump-wells, River Wandle.
St. George (East)	48,376	21	43	East London.
Camberwell	54,667	22	40	Southwark & Vauxhall, Lambeth.
Stepney	110,775	40	34	East London.

(*continued*)

Table V *(continued)*

Districts	Population in 1853 (estimated)	Deaths by Chol. In 17 wks., Aug. 21 to Dec. 17, 1853	Deaths by Cholera to 100,000 living	Water Supply
Lambeth	139,325	48	34	Lambeth, Southwark & Vauxhall.
Greenwich	99,365	32	31	Kent.
Marylebone	157,696	48	30	West Middlesex.
Westminster	65,609	19	27	Chelsea.
St. James, Westminster	36,406	9	25	Grand Junction, New River.
Hackney	58,429	13	22	New River, East London.
Paddington	46,305	10	22	Grand Junction.
Shoreditch	109,257	23	21	New River, East London.
Bethnal Green	90,193	18	20	East London.
Poplar	47,162	9	17	East London.
West London	28,840	4	14	New River.
Hanover Sq. and May Fair	33,196	5	12	Grand Junction.
Islington	95,329	12	12	New River.
Chelsea	56,538	6	11	Chelsea.
East London	44,406	4	9	New River.
London City	55,932	5	9	New River.
Clerkenwell	64,778	5	8	New River.
Belgrave	40,034	3	8	Chelsea.
St. Martin-in-the-Fields	24,640	1	5	New River.
St. Pancras	166,956	8	5	New River, Hampstead, West Middlesex.
St. Luke	54,055	2	4	New River.
Lewinsham	34,835	1	3	Kent.
Holborn	46,571	1	2	New River.
St. Giles	54,214	1	2	New River.
Strand	44,460	—	—	New River.
Hampstead	11,986	—	—	Hampstead, West Middlesex.
Total	2,362,236	796	—	

It will be observed that Lambeth, which is supplied with water in a great measure by the Lambeth Company, occupies a lower position in the above table than it did in the previous table showing the mortality in 1849. Rotherhithe also has been removed from the first to the fifth place; owing no doubt, to the portion of the district supplied with water from the Kent Water Works, instead of the ditches, being altogether free from the disease, as was noticed above.

As the Registrar-General published a list of all the deaths from cholera which occurred in London in 1853, from the commencement of the epidemic in August to its conclusion in January 1854, I have been able to add up the number which occurred in the various sub-districts on the south side of the Thames, to which the water supply of the Southwark and Vauxhall, and the Lambeth Companies, extends. I have presented them in Table VI, arranged in three groups.

Besides the general result shown in the table, there are some particular acts well worthy of consideration. In 1849, when the water of the Lambeth Company was quite as impure as that of the Southwark and Vauxhall Company, the parish of Christchurch suffered a rather higher rate of mortality from cholera than the adjoining parish of St. Saviour; but in 1853, whilst the mortality in St. Saviour's was at the rate of two hundred and twenty-seven to one hundred thousand living, that of Christchurch was only at the rate of forty-three. Now St. Saviour's is supplied with water entirely by the Southwark and Vauxhall Company, and Christchurch is chiefly supplied by the Lambeth Company. The pipes and other property of the Lambeth Company, in the parish of Christchurch, are rated at about £316, whilst the properly of the Southwark and Vauxhall Company in this parish is only rated at about £108. Waterloo Road, 1st part, suffered almost as much as St. Saviour's in 1849, and had but a single death in 1853; it is supplied almost exclusively by the Lambeth Company. The sub-districts of Kent Road and Borough Road which suffered severely from cholera, are supplied, through a great part of their extent, exclusively by the Southwark and Vauxhall Company; the supply of the Lambeth Company being intermingled with that of the other only in a part of these districts, as may be seen by consulting the accompanying map (No. 2). The rural districts of Wandsworth and Peckham contain a number of pump-wells, and are only, partially supplied by the Water Company; on this account they suffered a lower mortality than the other sub-districts supplied with the water from Battersea Fields. In the three sub-districts to which this water does not extend, there was no death from cholera in 1853.

Although the facts shown in the above table afford very strong evidence of the powerful influence which the drinking of water containing the sewage of a town exerts over the spread of cholera, when that disease is present, yet the question does not end here; for the intermixing of the

Table VI

Sub-Districts	Population in 1851	Deaths from Cholera in 1853	Deaths by Cholera, 100,000 living	Water Supply
St. Saviour, Southwark	19,709	45	227	Southwark and Vauxhall Water Company only.
St. Olave	8,015	19	237	
St. John, Horsleydown	11,360	7	61	
St. James, Bermondsey	18,899	21	111	
St. Mary Magdalen	13,934	27	193	
Leather Market	15,295	23	153	
Rotherhithe*	17,805	20	112	
Wandsworth	9,611	3	31	
Battersea	10,560	11	104	
Putney	17,742	—	—	
Camberwell	5,280	9	50	
Peckham	19,444	7	36	
Christchurch, Southwark	16,022	7	43	Lambeth Water Company, and Southwark and Vauxhall Company.
Kent Road	18,126	37	204	
Borough Road	15,862	26	163	
London Road	17,836	9	50	
Trinity, Newington	20,922	11	52	
St. Peter, Walworth	29,861	23	77	
St. Mary, Newington	14,033	5	35	
Waterloo (1st part)	14,088	1	7	
Waterloo (2nd part)	18,348	7	38	
Lambeth Church (1st part)	18,409	9	48	
Lambeth Church (2nd part)	26,784	11	41	
Kennington (1st part)	24,261	12	49	
Kennington (2nd part)	18,848	6	31	

Sub-Districts	Population in 1851	Deaths from Cholera in 1853	Deaths by Cholera, 100,000 living	Water Supply
Brixton	14,610	2	13	
Clapham	16,290	10	61	
St. George, Camberwell	15,849	6	37	
Norwood	3,977	—	—	Lambeth Water Company only.
Streatham	9,023	—	—	
Dulwich	1,632	—	—	
First 12 sub-districts	167,654	192	114	Southwark and Vauxhall.
Next 16 sub-districts	301,149	182	60	Both Companies.
Last 3 sub-districts	14,632	—	—	Lambeth Company.

* A small part of Rotherhithe is now supplied by the Kent Water Company.

water supply of the Southwark and Vauxhall Company with that of the Lambeth Company, over an extensive part of London, admitted of the subject being sifted in such a way as to yield the most incontrovertible proof on one side or the other. In the sub-districts enumerated in the above table as being supplied by both companies, the mixing of the supply is of the most intimate kind. The pipes of each Company go down all the streets, and into nearly all the courts and alleys. A few houses are supplied by one Company and a few by the other, according, to the decision of the owner or occupier at that time when the Water Companies were in active competition. In many cases a single house has a supply different from that on either side. Each company supplies both rich and poor, both large houses and small; there is no difference either in the condition or occupation of the persons receiving the water of the different Companies. Now it must be evident that, if the diminution of cholera, in the districts partly supplied with the improved water, depended on this supply, the houses receiving it would be the houses enjoying the whole benefit of the diminution of the malady, whilst the houses supplied with the water from Battersea Fields would suffer the same mortality as they would if the improved supply did not exist at all. As there is no difference whatever, either in the houses or the people receiving the supply of the two Water Companies, or in any of the physical conditions with which they are surrounded, it is obvious that no experiment could have been devised which would more thoroughly test the effect of water supply on the progress of cholera than this, which circumstances placed ready made before the observer.

The experiment, too, was on the grandest scale. No fewer than three hundred thousand people of both sexes, of every age and occupation, and of every rank and station, from gentle folks down to the very poor, were divided into two groups without their choice, and, in most cases, without their knowledge; one group being supplied with water containing the sewage of London, and, amongst it, whatever might have come from the cholera patients, the other group having water quite free from such impurity.

To turn this grand experiment to account, all that was required was to learn the supply of water to each individual house where a fatal attack of cholera might occur. I regret that, in the short days at the latter part of last year, I could not spare the time to make the inquiry; and, indeed, I was not fully aware, at that time, of the very intimate mixture of the supply of the two Water Companies, and the consequently important nature of the desired inquiry.

When the cholera returned to London in July of the present year, however, I resolved to spare no exertion which might be necessary to ascertain the exact effect of the water supply on the progress of the epidemic, in the places where all the circumstances were so happily adapted for the inquiry. I was desirous of making the investigation myself, in order that I might have the most satisfactory proof of the truth or fallacy of the doctrine which I had been advocating for five years. I had no reason to doubt the correctness of the conclusions I had drawn from the great number of facts already in my possession, but I felt that the circumstance of the cholera-poison passing down the sewers into a great river, and being distributed through miles of pipes, and yet producing its specific effects, was a fact of so startling a nature, and of so vast importance to the community, that it could not be too rigidly examined, or established on too firm a basis.

I accordingly asked permission at the General Register Office to be supplied with the addresses of persons dying of cholera, in those districts where the supply of the two Companies is intermingled in the manner I have stated above. Some of these addresses were published in the "Weekly Returns," and I was kindly permitted to take a copy of others. I commenced my inquiry about the middle of August with two sub-districts of Lambeth, called Kennington, first part, and Kennington, second part. There were forty-four deaths in these sub-districts down to 12th August, and I found that thirty-eight of the houses in which these deaths occurred were supplied with water by the Southwark and Vauxhall Company, four houses were supplied by the Lambeth Company, and two had pump-wells on the premises and no supply from either of the Companies.

As soon as I had ascertained these particulars I communicated them to Dr. Farr, who was much struck with the result, and at his suggestion the Registrars of all the south districts of London were requested to make a return of the water supply of the house in which the attack took place, in all cases of death from cholera. This order was to take place after the 26th August, and I resolved to carry my inquiry down to that date, so that the facts might be ascertained for the whole course of the epidemic. I pursued my inquiry over the various other sub-districts of Lambeth, Southwark, and Newington, where the supply of the two Water Companies is intermixed, with a result very similar to that already given, as will be seen further on. In cases where persons had been removed to a workhouse or any other place, after the attack of cholera had commenced, I inquired the water supply of the house where the individuals were living when the attack took place.

The inquiry was necessarily attended with a good deal of trouble. There were very few instances in which I could at once get the information I required. Even when the water-rates are paid by the residents, they can seldom remember the name of the Water Company till they have looked for the receipt. In the case of working people who pay weekly rents, the rates are invariably paid by the landlord or his agent, who often lives at a distance, and the residents know nothing about the matter. It would, indeed, have been almost impossible for me to complete the inquiry, if I had not found that I could distinguish the water of the two companies with perfect certainty by a chemical test. The test I employed was founded on the great difference in the quantity of chloride of sodium contained in the two kinds of water at the time I made the inquiry. On adding solution of nitrate of silver to a gallon of the water of the Lambeth Company, obtained at Thames Ditton, beyond the reach of the sewage of London, only 2–28 grains of chloride of silver were obtained, indicating the presence of 95 grams of chloride of sodium in the water. On treating the water of the Southwark and Vauxhall Company in the same manner, 91 grains of chloride of silver were obtained, showing the presence of 37–9 grains of common salt per gallon. Indeed, the difference in appearance on adding, nitrate of silver to the two kinds of water was so great, that they could be at once distinguished without any further trouble. Therefore when the resident could not give clear and conclusive evidence about the Water Company, I obtained some of the water in a small phial, and wrote the address on the cover, when I could examine it after coming home. The mere appearance of the water generally afforded a very good indication of its source, especially if it was observed as it came in, before it had entered the water-butt or cistern; and the time of its coming in also afforded some evidence of the kind of water, after I had ascertained the hours when the turncocks of both Companies visited any street. These points were, however, not relied on, except as corroborating more decisive proof, such as the chemical test, or the Company's receipt for the rates.

A return had been made to Parliament of the entire number of houses supplied with water by each of the Water Companies, but as the number of houses which they supplied in particular districts was not stated, I found that it would be necessary to carry my inquiry into all the districts to which the supply of either Company extends, in order to show the full bearing of the facts brought out in those districts where the supply is intermingled. I inquired myself respecting every death from cholera in the districts to which the supply of the Lambeth Company extends, and I was fortunate enough to obtain the assistance of a medical man, Mr. John Joseph Whiting, L.A.C., to make inquiry in Bermondsey, Rotherhithe, Wandsworth, and certain other districts, which are supplied only by the Southwark and Vauxhall Company. Mr. Whiting took great pains with his part of the inquiry, which was to ascertain whether the houses in which the fatal attacks took place were supplied with the Company's water, or from a pump-well, or some other source.

Mr. Whiting's part of the investigation extended over the first four weeks of the epidemic, from 8th July to 5th August; and as inquiry was made respecting every death from cholera during this part of the epidemic, in all the districts to which the supply of either of the Water Companies extends, it may be well to consider this period first. There were three hundred and thirty-four deaths from cholera in these four weeks, in the districts to which the water supply of the Southwark and Vauxhall and the Lambeth Company extends. Of these it was ascertained, that in two hundred and eighty-six cases the house where the fatal attack of cholera took place was supplied with water by the Southwark and Vauxhall Company, and in only fourteen cases was the house supplied with the Lambeth Company's water; in twenty-two cases the water was obtained by dipping a pail directly into the Thames, in four instances it was obtained from pump-wells, in four instances from ditches, and in four cases the source of supply was not ascertained, owing to the person being taken ill whilst traveling, or from some similar cause. The particulars of all the deaths which were caused by cholera in the first four weeks of the late epidemic, were published by the Registrar General in the "Weekly Returns of Births and Deaths in London," and I have had the three hundred and thirty-four above enumerated reprinted in an appendix to this edition [Not included. Ed.], as a guarantee that the water supply was inquired into, and to afford any person who wishes it an opportunity of verifying the result. Any one who should make the inquiry must be careful to find the house where the attack took place, for in many streets there are several houses having the same number.

According to a return which was made to Parliament, the Southwark and Vauxhall Company supplied 40,046 houses from January 1st to December 31st, 1853, and the Lambeth Company supplied 26,107 houses during the same period; consequently, as 286 fatal attacks of cholera took place, in the first four weeks of the epidemic, in houses supplied by the former Company, and only 14 in houses supplied by the latter, the proportion of fatal attacks to each 10,000 houses was as follows: Southwark and Vauxhall, 71; Lambeth, 5. The cholera was therefore fourteen times as fatal at this period, amongst persons having the impure water of the Southwark and Vauxhall Company, as amongst those having the purer water from Thames Ditton.

It is extremely worthy of remark, that whilst only five hundred and sixty-three deaths from cholera occurred in the whole of the metropolis, in the four weeks ending 5th August, more than one half of them took place amongst the customers of the Southwark and Vauxhall Company and a great portion of the remaining deaths were those of mariners and persons employed amongst the shipping in the Thames, who almost invariably draw their drinking water direct from the river. It may, indeed, be confidently asserted, that if the Southwark and Vauxhall Water Company had been able to use the same expedition as the Lambeth Company in completing their new works, and obtaining water free from the contents of sewers, the late epidemic of cholera would have been confined in a great measure to persons employed among the shipping, and to poor people who get water by pailsful direct from the Thames or tidal ditches.

The number of houses in London at the time of the last census was 327,391. If the houses supplied with water by the Southwark and Vauxhall Company, and the deaths from cholera occurring in these houses, be deducted, we shall have in the remainder of London 287,345 houses, in which 277 deaths from cholera took place in the first four weeks of the epidemic. This is at the rate of nine deaths to each 10,000. But the houses supplied with water by the Lambeth Company only suffered a mortality of five in each 10,000 at this period; it follows, therefore, that these houses, although intimately mixed with those of the Southwark and Vauxhall Company, in which so great a proportional mortality occurred, did not suffer even so much as the rest of London which was not so situated.

In the beginning of the late epidemic of cholera in London, the Thames water seems to have been the great means of its diffusion, either through the pipes of the Southwark and Vauxhall Company, or more directly by dipping a pail in the river. Cholera was prevailing in the Baltic Fleet in the early part of summer, and the following passage from the "Weekly Returns" of the Registrar-General shows that the disease was probably imported thence to the Thames.

Bermondsey, St. James. At 10, Marine Street, on 25th July, a mate mariner, aged 34 years, Asiatic cholera 101 hours, after premonitory diarrhoea 16½ hours. The medical attendant states: 'This patient was the chief mate to a steam-vessel taking stores to and bringing home invalids from the Baltic Fleet. Three weeks ago he brought home in his cabin the soiled linen of an officer who had been ill. The linen was washed and returned.'

The time when this steam-vessel arrived in the Thames with the soiled linen on board, was a few days before the first cases of cholera appeared in London, and these first cases were chiefly amongst persons connected with the shipping in the river. It is not improbable therefore that a few simple precautions, with respect to the communications with the Baltic Fleet, might have saved London from the cholera this year, or at all events greatly retarded its appearance.

As the epidemic advanced, the disproportion between the number of cases in houses supplied by the Southwark and Vauxhall Company and those supplied by the Lambeth Company, became not quite so great, although it continued very striking. In the beginning of the epidemic the cases appear to have been almost altogether produced through the agency of the Thames water obtained amongst the sewers and the small number of cases occurring in houses not so supplied, might be accounted for by the fact of persons not keeping always at home and taking all their meals in the houses in which they live; but as the epidemic advanced it would necessarily spread amongst the customers of the Lambeth Company, as in parts of London where the water was not in fault, by all the usual means of its communication. The two subjoined tables, VII and VIII, show the number of fatal attacks in houses supplied respectively by the two Companies, in all the sub-districts to which their water extends. The cases in Table VII, are again included in the larger number which appear in the next table. The sub-districts are arranged in three groups, as they were in Table VI, illustrating the epidemic of 1853.

In Table VIII, showing the mortality in the first seven weeks of the epidemic, the water supply is the result of my own personal inquiry, in every case, in all the sub-districts to which the supply of the Lambeth Company extends; but in some of the sub-districts supplied only by the Southwark and Vauxhall Company, the inquiry of Mr. Whiting having extended only to 5th August, the water supply of the last three weeks is calculated to have been in the same proportion by the Company, or by pump wells, etc., as in the first four weeks,—a calculation which is perfectly fair, and must be very near the truth. The sub-districts in which the supply is partly founded on computation, are marked with an asterisk.

The numbers in Table VIII differ a very little from those of the table I communicated to the Medical Times and Gazette of 7th October, on account

Table VII Mortality from Cholera in the four weeks ending 5th August

Sub-Districts	Population in 1851	Deaths from Cholera in the four wks ending 5th August	Water Supply				
			Southwark & Vauxhall	Lambeth	Pump-wells	River Thames and ditches	Unascertained
*St. Saviour, Southwark	19,709	26	24	—	—	2	—
*St. Olave	8,015	19	15	—	—	2	2
*St. John, Horsley-down	11,360	18	17	—	—	1	—
*St. James, Bermond-sey	18,899	29	23	—	—	6	—
*St. Mary Magdalen	13,934	20	19	—	—	1	—
*Leather Market	15,295	23	23	—	—	—	—
*Rotherhithe	17,805	26	17	—	—	9	—
*Battersea	10,560	13	10	—	1	2	—
Wandsworth	9,611	2	—	—	—	2	—
Putney	5,280	1	—	—	1	—	—
*Camberwell	17,742	19	19	—	—	—	—
*Peckham	19,444	4	4	—	—	—	—
Christchurch, Southwark	16,022	3	2	1	—	—	—
Kent Road	18,126	8	7	1	—	—	—
Borough Road	15,862	21	20	1	—	—	—
London Road	17,836	9	5	4	—	—	—
Trinity, Newing-ton	20,922	14	14	—	—	—	—
St. Peter, Walworth	29,861	20	20	—	—	—	—

(continued)

Table VII *(continued)*

Sub-Districts	Population in 1851	Deaths from Cholera in the four wks ending 5th August	Water Supply				
			South-wark & Vaux-hall	Lam-beth	Pump-wells	River Thames and ditches	Unascer-tained
St. Mary, Newington	14,033	5	5	—	—	—	—
Waterloo (1st pt)	14,088	5	5	—	—	—	—
Waterloo (2nd pt)	18,348	5	5	—	—	—	—
Lambeth Church (1st part)	18,409	5	2	1	—	1	1
Lambeth Church (2nd part)	26,748	10	7	2	—	—	1
Kennington (1st part)	24,261	11	9	1	—	—	—
Kennington (2nd part)	18,848	3	3	—	—	—	—
Brixton	14,610	1	—	1	—	—	—
*Clapham	16,290	5	4	—	1	—	—
St. George, Camber-well	15,849	9	7	2	—	—	—
Norwood	3,977	—	—	—	—	—	—
Streatham	9,023	—	—	—	—	—	—
Dulwich	1,632	—	—	—	—	—	—
Sydenham	4,501	—	—	—	—	—	—
Total	486,936	334	286	14	4	26	4

Table VIII Mortality from Cholera in the seven weeks ending 26th August

Sub-Districts	Population in 1851	Deaths from Cholera in the four wks ending 5th August	Water Supply				
			Southwark & Vauxhall	Lambeth	Pump-wells	River Thames and ditches	Unascertained
*St. Saviour, Southwark	19,709	125	115	—	—	10	—
*St. Olave	8,015	53	43	—	—	55	5
*St. John, Horsley-down	11,360	51	48	—	—	3	—
*St. James, Bermond-sey	18,899	123	102	—	—	21	—
*St. Mary Magdalen	13,934	87	83	—	—	4	—
*Leather Market	15,295	81	81	—	—	—	—
*Rotherhithe	17,805	103	68	—		35	—
*Battersea	10,560	54	42	—	4	8	—
Wandsworth	9,611	11	1	—	2	8	—
Putney	5,280	1	—	—	1	—	—
*Camberwell	17,742	96	96	—	—	—	—
*Peckham	19,444	59	59	—	—	—	—
Christchurch, Southwark	16,022	25	11	13	—	—	1
Kent Road	18,126	57	52	5	—	—	—
Borough Road	15,862	71	61	7	—	—	3
London Road	17,836	29	21	8	—	—	—
Trinity, Newington	20,922	58	52	6	—	—	—
St. Peter, Walworth	29,861	90	84	4	—	—	2

(continued)

Table VIII *(continued)*

Sub-Districts	Population in 1851	Deaths from Cholera in the four wks ending 5th August	Water Supply				
			Southwark & Vauxhall	Lambeth	Pump-wells	River Thames and ditches	Unascertained
St. Mary, Newington	14,033	21	19	1	1	—	—
Waterloo (1st pt)	14,088	10	9	1	—	—	—
Waterloo (2nd pt)	18,348	36	25	8	1	2	—
Lambeth Church (1st part)	18,409	18	6	9	—	1	2
Lambeth Church (2nd part)	26,748	53	34	13	1	—	5
Kennington (1st part)	24,261	71	63	5	3	—	—
Kennington (2nd part)	18,848	38	34	3	1	—	—
Brixton	14,610	9	5	2	—	—	2
*Clapham	16,290	24	19	—	5	—	—
St. George, Camberwell	15,849	42	30	9	2	—	1
Norwood	3,977	8	—	2	1	5	—
Streatham	9,023	6	—	1	5	—	—
Dulwich	1,632	—	—	—	—	—	—
Sydenham	4,501	4	—	1	2	—	1
Total	486,936	1,514	1,263	98	29	102	22

of the water supply having since been ascertained in some cases in which I did not then know it. The small number of instances in which the water supply remains unascertained are chiefly those of persons taken into a workhouse without their address being known.

The following is the proportion of deaths to 10,000 houses, during the first seven weeks of the epidemic, in the population supplied by the Southwark and Vauxhall Company, in that supplied by the Lambeth Company, and in the rest of London.

The mortality in the houses supplied by the Southwark and Vauxhall Company was therefore between eight and nine times as great as in the houses supplied by the Lambeth Company; and it will be remarked that the customers of the Lambeth Company continued to enjoy an immunity from cholera greater than the rest of London which is not mixed up as they are with the houses supplied by the Southwark and Vauxhall Company. As regards the period of the epidemic subsequent to the 26th August to which my inquiry extended, I have stated that the Registrar General requested the District Registrars to make a return of the water supply of the house of attack in all cases of death from cholera. Owing to difficulties such as I explained that I had met with in the beginning of my inquiry, the Registrars could not make the return in all cases, and as they could not be expected to seek out the landlord or his agent, or to apply chemical tests to the water as I had done, the water supply remained unascertained in a number of cases, but the numbers may undoubtedly be considered to show the correct proportions as far as they extend, and they agree entirely with the results of my inquiry respecting the earlier part of the epidemic given above.

The Registrar General published the returns of the water supply, which he had obtained from the District Registrars, down to 14th October, in a table which is subjoined. As the whole of the south districts of London were included in the inquiry of the Registrar General, the deaths in the Greenwich and Lewisham districts which are supplied by the Kent Water

Table IX

	Number of houses	Deaths from Cholera	Deaths in each 10,000 houses
Southwark and Vauxhall Company	40,046	1,263	315
Lambeth Company	26,107	98	37
Rest of London	256,423	1,422	59

Table X

Week Ending	Deaths from Cholera	Water Supply				
		Southwark and Vauxhall	Lambeth	Kent Company	Pumps, and other sources	Not ascertained
Sept 2	670	399	45	38	72	116
Sept 9	972	580	72	45	62	213
Sept 16	856	524	66	48	44	174
Sept 23	724	432	72	28	62	130
Sept 30	383	228	25	19	24	87
Oct 7	200	121	14	10	9	46
Oct 14	115	69	8	3	6	29
Total	3,920	2,353	302	191	279	795

Company, and did not enter into my inquiry, are included in the table, but they do not in the least affect the numbers connected with the other companies.

Now 2,353 deaths in 40,046 houses, the number supplied by the Southwark and Vauxhall Company are 573 deaths to each 10,000 houses; and 302 deaths to 26,107, the number of houses supplied by the Lambeth Company, are 115 deaths to each 10,000 houses; consequently in the second seven weeks of the epidemic, the population supplied by the Southwark and Vauxhall Company continued to suffer nearly five times the mortality of that supplied with water by the Lambeth Company. If the 795 deaths in which the water supply was not ascertained be distributed equally over the other sources of supply in the above table (No. X), the deaths in houses supplied by the Southwark and Vauxhall Company would be 2,830, and in houses supplied by the Lambeth Company would be 363. By adding the number of deaths which occurred in the first seven weeks of the epidemic, we get the numbers in the subjoined table (No. XI), where the population of the houses supplied by the two water companies is that estimated by the Registrar General.[14]

We see by the above table that the houses supplied with the water from Thames Ditton, by the Lambeth Company, continued throughout the epidemic to enjoy an immunity from cholera, not only greater than London at large, but greater than every group of districts, except the north and central groups.

Table XI

	Population in 1851	Deaths by Cholera in 14 wks. Ending Oct. 14	Deaths in 10,000 living
London	2,362,236	10,367	43
West Districts	376,427	1,992	53
North Districts	490,396	735	14
Central Districts	393,256	612	15
East Districts	485,522	1,461	30
South Districts	616,635	5,567	90
Houses supplied by Southwark and Vauxhall Company	266,516	4,093	153
Houses supplied by Lambeth Company	173,748	461	26

In the next table (No. XII), the mortality from cholera in 1849 is shown side by side with that of 1854, in the various sub-districts to which the supply of the two water companies with which we are particularly interested extends. The mortality of 1854 is down to October 21, and is extracted from a table published in the "Weekly Return of Births and Deaths" of October 28 that of 1849 is from the "Report on Cholera" by Dr. Farr, previously quoted. The sub-districts are arranged in three groups as before, the first group being supplied only by the Southwark and Vauxhall Company, the second group by this Company and the Lambeth, and the third group by the Lambeth Company only. It is necessary to observe, however, that the supply of the Lambeth Company has been extended to Streatham, Norwood, and Sydenham, since 1849, in which year these places were not supplied by any water company. The situation and extent of the various sub-districts are shown, together with the nature of the water supply, in Map 2, which accompanies this work.

The table exhibits an increase of mortality in 1854 as compared with 1849, in the sub-districts supplied by the Southwark and Vauxhall Company only, whilst there is a considerable diminution of mortality in the sub-districts partly supplied by the Lambeth Company. In certain sub-districts, where I know that the supply of the Lambeth Water Company is more general than elsewhere, as Christchurch, London Road, Waterloo Road 1st, and Lambeth Church 1st, the decrease of mortality in 1854 as

Table XII

Sub-Districts	Deaths from Cholera in 1849	Deaths from Cholera in 1854	Water Supply
St. Saviour, Southwark	283	371	Southwark and Vauxhall Water Company only.
St. Olave	157	161	
St. John, Horsleydown	192	148	
St. James, Bermondsey	249	362	
St. Mary Magdalen	259	244	
Leather Market	226	237	
Rotherhithe*	352	282	
Wandsworth	97	59	
Battersea	111	171	
Putney	8	9	
Camberwell	235	240	
Peckham	92	174	
Christchurch, Southwark	256	113	Lambeth Water Company, and Southwark and Vauxhall Company.
Kent Road	267	174	
Borough Road	312	270	
London Road	257	93	
Trinity, Newington	318	210	
St. Peter, Walworth	446	388	
St. Mary, Newington	143	92	
Waterloo (1st part)	193	58	
Waterloo (2nd part)	243	117	
Lambeth Church (1st part)	215	49	
Lambeth Church (2nd part)	544	193	
Kennington (1st part)	187	303	
Kennington (2nd part)	153	142	
Brixton	81	48	

Sub-Districts	Deaths from Cholera in 1849	Deaths from Cholera in 1854	Water Supply
Clapham	114	165	
St. George, Camberwell	176	132	
Norwood	2	10	Lambeth Water Company only.
Streatham	154	15	
Dulwich	1	—	
Sydenham	5	12	
First 12 sub-districts	2,261	2,458	Southwark and Vauxhall.
Next 16 sub-districts	3,905	2,547	Both Companies.
Last 4 sub-districts	162	37	Lambeth Company.

* A small part of Rotherhithe is now supplied by the Kent Water Company.

compared with 1849 is greatest, as might be expected. Waterloo Road 1st, which suffered but little from cholera in the present year, is chiefly composed of very dirty narrow streets, in the neighbourhood of Cornwall Road and the New Cut, inhabited by very poor people; and Lambeth Church 1st, which suffered still less, contains a number of skin yards and other factories, between Lambeth Palace and Vauxhall Bridge, which have often been inveighed against as promoting the cholera. The high mortality of the Streatham district in 1849 was caused by the outbreak of cholera in Drouett's Asylum for pauper children, previously mentioned.

Whilst making inquiries in the south districts of London, I learned some circumstances with respect to the workhouses which deserve to be noticed. In Newington Workhouse, containing 650 inmates, and supplied with the water from Thames Ditton, there had been but two deaths from cholera amongst the inmates down to 21st September, when the epidemic had already greatly declined. In Lambeth Workhouse, containing, if I remember rightly, nearly 1,000 inmates, and supplied with the same water, there had been but one death amongst the inmates when I was there in the first week of September. In St. Saviour's workhouse, which is situated in the parish of Christchurch, and is supplied with water by the Lambeth Company, no inmate died of cholera before I called in the first week of September. On the other hand, in the workhouse of St. George, Southwark, supplied with the water of the Southwark and Vauxhall Company, six inmates died out of about 600 before the 26th August, when the epidemic had only run one-third of its course. The mortality was also high amongst the inmates of St. Olave's Workhouse, supplied with water by the Southwark and Vauxhall Company, but I do not know the number who died. I trust, however, that the Registrar General, in giving an account of the recent epidemic, will make a return of the deaths amongst the inmates of the various workhouses and other institutions on the south side of the Thames, together with the water supply of the buildings. Bethlehem Hospital, the Queen's Prison, Horsemonger Lane Gaol, and some other institutions, having deep wells on the premises, scarcely suffered at all from cholera in 1849, and there was no death in any of them during the part of the recent epidemic to which my inquiry extended.

On the north side of the Thames the mortality during the recent epidemic seems to have been influenced more by the relative crowding and want of cleanly habits of the people, and by the accidental contamination of the pump-wells, than by the supply of the water companies. The water of the New River Company could have no share in the propagation of cholera, as I explained when treating of the epidemic of 1849; and the extensive districts supplied by this company have been very slightly visited by the disease, except in certain spots which were influenced by the causes above mentioned. The water of the East London Company is also free from the contents of sewers, unless it be those from the neighbourhood of Upper Clapton, where there has been very little cholera. The districts supplied by this company have been lightly visited, except such as lie near the Thames, and are inhabited by mariners, coal and ballast-heavers, and others, who are employed on the river. Even Bethnal Green and Spitalfields, so notorious for their poverty and squalor, have suffered a mortality much below the average of the metropolis. The Grand Junction Company obtain their supply at Brentford, within the reach of the tide and near a large population, but they detain the water in large reservoirs, and their officers tell me they filter it; at all events, they supply it in as pure a state as that of the Lambeth Company obtained at Thames Ditton, and their districts have suffered very little from cholera except at the spot where the irruption occurred from the contamination of the pump-well in Broad Street, Golden Square. The West Middlesex Company, obtaining their supply from the Thames at Hammersmith, have also very large reservoirs, and the districts they supply have suffered but little from cholera, except the Kensington brick fields, Starch Green, and certain other spots, crowded with poor people, chiefly Irish.

The districts supplied by the Chelsea Company have suffered a much greater mortality, during the recent epidemic, than the average of the whole metropolis, as the subjoined table (No. XIII) shows.

Table XIII

	Population in 1851	Deaths by Cholera	
		In 15 Wks. Ending Oct 21	To every 10,000 living
Chelsea, south	19,050	122	64
Chelsea, north-west	17,669	99	56
Chelsea, north-east	19,819	71	36
Belgrave	40,034	238	59
St. John, Westminster	34,295	173	50
St. Margaret, Westminster	31,314	238	76
Total of districts supplied by the Chelsea Water Company	162,181	941	56
Houses supplied by the Southwark and Vauxhall Company	266,516	2,900	108
London	2,362,236	10,530	45
London, except the houses supplied by the Chelsea Company, and by the Southwark and Vauxhall Company.	1,933,539	6,689	34

But the mortality in these districts is only half as great as in the houses supplied by the Southwark and Vauxhall Company, who obtain their supply from the Thames just opposite the spot where the Chelsea Company obtain theirs. The latter company, however, by detaining the water in their reservoirs, and by filtering it, are enabled to distribute it in a state of comparative purity; but I had ample opportunities of observing, in August and September last, that this was far from being the state of the water supplied by the Southwark and Vauxhall Company. Many of the people receiving this latter supply were in the habit of tying a piece of linen or some other fabric over the tap by which the water entered the butt or cistern, and in two hours, as the water came in, about a tablespoon of dirt was collected, all in motion with a variety of water insects, whilst the strained water was far from being clear. The contents of the strainer were shown to me in scores of instances. I do not, of course, attribute the cholera either to the insects or the visible dirt; but it is extremely probable that the measures adopted by the Chelsea Company to free the water from these repulsive ingredients, either separated or caused the destruction of the morbid matter of cholera. It is very likely that the detention of the water in the Company's reservoirs permitted the decomposition of the cholera poison, and was more beneficial than the filtering, for the following reasons. The water used in Millbank Prison, obtained from the Thames at Millbank, was filtered through sand and charcoal till it looked as clear as that of the Chelsea Company; yet, in every epidemic, the inmates of this prison suffered much more from cholera than the inhabitants of the neighbouring streets and those of Tothill Fields Prison, supplied by that company.[15] In the early part of August last, the use of the Thames water was entirely discontinued in Millbank Prison, and water from the Artesian well in Trafalgar Square was used instead, on the recommendation of Dr. Baly, the physician to the prison. In three or four days after this change, the cholera, which was prevailing to an alarming extent, entirely ceased.

The quantity of impurity in the Thames was greatly increased during the late autumn, by the long course of dry weather. From 5th August to 12th September, a period of more than five weeks, only 0.29 of an inch of rain fell at Greenwich, as appears by the report of the Astronomer Royal. The stream of the Thames above the reach of the tide became so slender, that it was difficult to navigate barges above Richmond. The Thames in London is a very large body of water, and if the whole of it flowed away into the sea every day, the liquid which flows down the sewers in twelve hours would form but a very small part of it; but it must be remembered that the quantity of water which passes out to sea, with the ebb of every tide, is only equal to that which flows over Teddington Lock, and from a few small tributary streams. In hot dry weather this quantity is moreover greatly diminished by the evaporation taking place from the immense surface of water exposed between Richmond and Graves end, so that the river becomes a kind of prolonged lake, the same water passing twice a day to and fro through London, and receiving the excrement of its two millions and more of inhabitants, which keeps accumulating till there is a fall of rain. In time of cholera, the evacuations of the patients keep accumulating in the river along with the other impurities; and it is probably in this way that the dry weather with a high barometer aids in promoting cholera, as it has often been observed to do.

I thought at first that the quantity of common salt, previously mentioned as being present in the water of the Southwark and Vauxhall Company, consisted entirely of the salt which had passed down the sewers into the river, for I had no idea that any admixture of sea water reached as high as Battersea Fields. Mr. Quick, the engineer of the above Company, informed me, however, that an impregnation of salt water does extend as far after a long course of dry weather. It is obvious that a dry season, whilst it increases the quantity of impurity in the Thames, must also cause the sea water to flow further inland than at other times. I did not examine the water of the Thames in August or September, but I have done so now, at the latter part of November, and I am inclined to think that even yet a slight admixture of sea water may reach to Battersea Fields with every tide. I found 5.8 grains of chloride of sodium per gallon, in water obtained at Hungerford Market, at half flow of the tide, on 19th November, and 19.1 grains per gallon, in water obtained at the same place, on 27th November, at an hour and a half before high water; whilst water obtained at London Bridge, on 28th November, at high water, contained 63.3 grains per gallon.

A specimen of water obtained on 21st November, from a house supplied by the Southwark and Vauxhall Company, contained 28.8 grains of common salt per gallon, or about three-quarters as much as it contained in September, when the quantity was 37.9 grains. It is very obvious from the above analyses, that the Water Company, obtain their supply from the Thames at high water, or nearly so, although this is the time of the tide when the water contains the greatest amount of impurity. It is quite certain that the sea water cannot reach to Thames Ditton, any more than the contents of the London sewers, and therefore, whatever may be its source, the quantity of chloride of sodium in the water is quite conclusive as regards the purpose for which I examined into it, *viz.*, to distinguish between the water of the two Companies.

When the water of the Southwark and Vauxhall Company was examined by Messrs. Graham, Miller, and Hofmann, at the latter part of January 1851, it contained only 1.99 grains of chloride of sodium, or about one-twentieth as much as it contained last September, and one-fifteenth as much as on 21st November 1854.[16]

Dr. Farr discovered a remarkable coincidence between the mortality from cholera in the different districts of London in 1849, and the elevation of the ground; the connection being of an inverse kind, the higher districts suffering least, and the lowest suffering most from this malady. Dr. Farr was inclined to think that the level of the soil had some direct influence over the prevalence of cholera, but the fact of the most elevated towns in this kingdom, as Wolverhampton, Dowlais, Merthyr Tydvil, and Newcastle-upon-Tyne, having suffered excessively from this disease on several occasions, is opposed to this view, as is also the circumstance of Bethlehem Hospital, the Queen's Prison, Horsemonger Lane Gaol, and several other large buildings, which are supplied with water from deep wells on the premises, having nearly or altogether escaped cholera, though situated on a very low level, and surrounded by the disease. The fact of Brixton, at an elevation fifty-six feet above Trinity high-water mark, having suffered a mortality of 55 in 10,000, whilst many districts on the north of the Thames, at less than half the elevation, did not suffer one-third as much also points to the same conclusion.

I expressed the opinion in 1849,[17] that the increased prevalence of cholera in the low-lying districts of London depended entirely on the greater contamination of the water in these districts, and the comparative immunity from this disease of the population receiving the improved water from Thames Ditton, during the epidemics of last year and the present, as shown in the previous pages, entirely confirms this view of the subject; for the great bulk of this population live in the lowest districts of the metropolis.

The prevalence of cholera has been very much under the influence of the water supply in other towns besides London. The cholera has prevailed to a considerable extent in the crowded habitations of the poor in Liverpool and some other towns, where the general supply of water was not in fault, but I know of no instance in which it has spread through all classes of the community, except where the general supply of water has been contaminated with the contents of the drains and sewers; and all the towns with which I am acquainted that have enjoyed an almost complete immunity from this disease, have a water supply quite free from any chance of contamination. Birmingham, Bath, Cheltenham, and Leicester have nearly escaped the cholera in every epidemic. The few cases that have occurred being, chiefly those of persons newly arrived from places where the disease was prevailing, and a few others who came in communication with them. All these towns have a supply of water quite free from connection with the drains and sewers, and the small rivers which flow through them are so impure that it would be impossible to drink the water. Leicester is crowded with a poor population and has hardly any physical advantage except its water supply.

The first cases of cholera in Exeter in 1832, were three in the same day, besides one in St. Thomas's, a suburb of Exeter, in a gentleman just arrived from London, where the disease was prevailing. The other three were a woman and her two children; the former, with one of her children, had returned from Plymouth the previous day, where she had been nursing a child that had died of the cholera. Within five days from this time, there were seven fresh cases in as many different parts of the town, amongst persons having no intercourse with each other or the first cases. The disease soon became very prevalent, and in three months there were 1,135 cases, and 345 deaths. Exeter is situated on ground which rises from the edge of the river to an elevation of one hundred and fifty feet. In 1832 the inhabitants were chiefly supplied with river water by water-carriers, who conveyed it in carts and pails. Dr. Shapter, from whose work[18] the above particulars are obtained, kindly furnished me with information concerning the sewers, and with maps of their position. The water-carriers, by whom Exeter was very greatly supplied, obtained their water almost exclusively from certain streams of water, diverted from the river in order to turn water-mills; and one of the chief sewers of the town, which receives such sewage as might come from North Street, in which the first cases of cholera occurred, empties itself into the branch from the river which divides into the two mill-streams just mentioned. It must be remarked that the parish of St. Edmund, in which these streams of water were situated, had a lower mortality from cholera than other parts of the town like it, densely populated and on low ground near the river. Dr. Shapter attributes this lower rate of mortality, and I believe rightly, to St. Edmund's being freely intersected by running streams of water. The people would probably not drink more of the water than in parts of the town where it was less plentiful, and had to be paid for, but they would have much better opportunities for personal cleanliness: so that whilst they would be exposed to only the same number of scattered cases, they would be less likely to have the malady spreading through families, and by personal intercourse. After the cholera of 1832, measures were taken to afford a better supply of water to Exeter; not, so far as I can find by Dr. Shapter's work, that its impurity was complained of, but because of its scarcity and cost. Water-works were established on the river Exe, two miles above the town, and more than two miles above the influence of the tide. Exeter has since been very plentifully supplied with this water, and Dr. Shapter informed me that in 1849 there were only about twenty cases of cholera, nearly half of which occurred in strangers coming into the town, and dying within two or three days after their arrival. This last summer there was only one death from cholera in Exeter.

We will now consider the town of Hull, in which, together with other sanitary measures adopted since 1832, there has been a new more plentiful supply of water, but with a far different result to that at Exeter. In 1832 Hull was scantily supplied with water conveyed in pipes from springs at Anlaby, three miles from the town. About 1844, new water-works were established to afford a more plentiful supply. These works were situated on the river Hull, at Stoneferry, two miles and three quarters from the confluence of that river with the Humber. About half the sewage of the town is delivered into the river of the same name, the rest being discharged into the Humber, as appears from information and a map kindly furnished me in 1849 by Dr. Horner of Hull, who was making great efforts to have better water obtained for the town. The tide flows up the river many miles past the water-works, carrying up with it the filth from the sewers. The supply of water was, to be sure, obtained when the tide was down, but as the banks of the river are clothed with sedges in many parts, and its bottom deep with mud, the water can never be free from sewage. Moreover, there are some parts of the river above Stoneferry much deeper than the rest, and where the deeper water is, according to the testimony of boatmen, nearly stagnant; thus allowing the water carried up by the tide to remain and gradually mix with that afterwards flowing down. There are also boats, with families on board, passing up the river to the extent of five thousand voyages in the year. The water when taken from the river was allowed to settle in the reservoir for twenty-four hours, and was then said to be filtered before being sent to the town. In 1832 the cholera was confined almost exclusively to the poor, and the deaths amounted to three hundred.

In 1849 the deaths in Hull (including the suburb of Sculcoates) were 1834, although 8,000 or 10,000 left the town, it is said, to avoid the ravages of the disease. Dr. Homer informed me that the deaths occurred amongst all classes of the community, and that the town was much better drained in 1849 than in 1832.

When the cholera made its appearance at York, about the middle of July 1849, it was at first chiefly prevalent in some narrow streets near the river, called the Water Lanes. The inhabitants of this spot had been in the habit, from time immemorial, of fetching their water from the river at a place near which one of the chief sewers of the towns empties itself; and recently a public necessary had been built, the contents of which were washed every morning into the river just above the spot at which they got the water. In a short time from twenty to thirty deaths occurred in this locality but the medical men considering the impure water injurious, the people were supplied from the water-works, with water obtained from the river at a point some distance above the town, and the cholera soon ceased nearly altogether in this part of the city, but continued to spread in some other parts. The cholera having thus abated in the Water Lanes, the gratuitous supply of water was cut off, and the people went to the river as before. There were still cases of cholera in the town, and it soon broke out again in this locality, and in the first few days of September eight deaths occurred among the persons who used water obtained direct from the river. The tap for general use was again opened, and the river water interdicted, and the cholera again ceased, and did not recur. These circumstances were communicated to me by a friend on whose accuracy I can rely.

The inhabitants of Dumfries drink the water of the river Nith, which flows through the town, and into which the sewers discharge their contents, which float afterwards to and fro with the tide. In 1832 there were 418 deaths from cholera out of a population of 11,606, being at the rate of 360 in 10,000, or 1 in every 28 of the inhabitants. The cholera again visited Dumfries at the close of 1848, and carried off 431 persons, or 1 in every 32, out of a population now numbering 14,000; so that the mortality was excessive on both occasions.

Preston and Oldham, in Lancashire, are supplied with water from surface drainage on the neighbouring hills and there was scarcely any cholera at either of these places in 1849. The greater part of the town of Paisley is supplied in a similar way; and I was informed that the cases of cholera which occurred there in 1849 were confined to a quarter of the town to which this supply of water does not extend. Nottingham is supplied with filtered water obtained from the river Trent, some distance above the town. In 1832 this supply did not extend to all the inhabitants, and the cholera was somewhat prevalent amongst the poor, of whom it carried off 289; the population of the town being 53,000. After that time the water was extended copiously to all the inhabitants, and there were but thirteen deaths from the epidemic in 1849. The local Sanitary Committee placed the supply of water amongst the chief causes of this immunity from cholera, and I believe justly. There were but seven deaths from cholera in Nottingham last summer.

Glasgow has been supplied, since the early part of the present century, with the water of the Clyde, obtained a little way above the town, but within the influence of the tide, and consequently mixed with the contents of the sewers. It is imperfectly filtered through sand. In 1847, however, the parish of Gorbals, which forms the south part of Glasgow, was furnished with a supply of water collected on the neighbouring hills; and Dr. Leech, of Glasgow, speaks as follows respecting the influence of this water on the prevalence of cholera:

During the late cholera there was a remarkable circumstance, which deserves notice as compared with the epidemic of 1832. Since the former period, the population of Glasgow, south of the Clyde, has nearly doubled and with this exception, and the introduction of the soft-water supply, the circumstances might be considered as the same at both periods. In one district, the parish of Gorbals, the attack in 1832 was fearful; while Glasgow, north of the Clyde, also suffered severely. During the late epidemic (that of 1848–49), Gorbals parish furnished comparatively a small number of cases while the epidemic in other parts of Glasgow was very severe. The unanimous opinion of the Medical Society was that this comparative immunity was to be attributed to the soft-water supply.[19]

I was informed that when the cholera was prevalent in Glasgow last winter, the parish of Gorbals again enjoyed a similar immunity from the disease.

The following passage respecting the water-supply of Paris is from Dr. Farr's "Report to the Registrar-General on the Cholera of 1848–49."

The supply of Paris is from various sources, but four-fifths of the water is from the Canal de l'Ourque, which, by the decision of Napoleon, was also appropriated to navigation. The water for some years, and in 1832, when the epidemic was so fatal, was drawn from the dirty basin in which the boats and barges of the canals rested; but is now drawn from the canal before it enters the basin. . . . The mortality of cholera in Paris was excessive, and in 1832, varied from 80, of 10,000 inhabitants, in the elegant Chaussée d'Antin and in Montmartre on the heights, to 530 and 520 in the low quartiers of the Hôtel de Ville and the Cité. (p. lxxviii).

The town of Newcastle-upon-Tyne affords a remarkable instance of the influence of the water-supply on the prevalence of cholera. In 1831–32 there were no waterworks at Newcastle; it was supplied, in an insufficient manner with spring water, which generally had to be carried some distance to the houses from "pants" in the streets. The epidemic was pretty severe at this time. From November 1831 to November 1832 there were 801 deaths from cholera out of a population of 42,760. The disease prevailed chiefly amongst the poor and was worst in the least elevated parts of the town, near the river. Subsequently to 1832, waterworks were established on the river Tyne, a little above the town; but these were abandoned, in 1848, in favour of a supply from a rivulet and springs at Whittle Dean, about ten miles distant. In 1849, there were but 295 deaths from cholera in a population then increased to 71,847. In the beginning of July 1853, two months before the reappearance of cholera in England, the Whittle Dean Water Company found their proper sources insufficient for the demands of the population and the various Factories, and they made use of the former waterworks, mentioned above, to obtain water from the Tyne. The point at which they obtained water from the river, is scarcely a mile above Newcastle, and the tide flows for six miles above the town, carrying the contents of the sewers with it. There are also villages, containing several thousands of colliers and iron founders, on the banks of the Tyne, above the waterworks. The water from the Tyne was mixed, without filtration, with that from Whittle Dean, to the extent of one-third; and the mixed water, so supplied, was discoloured, and contained the large quantity of 7.1 grains of organic matter per gallon.

In the autumn of 1853, the cholera was prevailing extensively at Hamburah, and in nearly all the ports of the Baltic, whence a number of ships were arriving every day in the Tyne. The first cases of cholera commenced, with diarrhoea, on the 27th and 28th August, at Bell Quay, on the banks of the Tyne, three miles below Newcastle. One of the patients from Bell Quay was taken worse whilst on a visit to her mother at Newcastle: she died on 2nd September. Her mother was taken ill the same evening, and died on the following day. Other cases occurred in Newcastle on the 1st and 2nd of September, having no connexion with these. A ship from Bremen was lying at Bell Quay, opposite the house where the first cases occurred; but there had been no illness on board this ship, and the precise way in which the cholera was introduced on this occasion, is not known.

The disease soon spread to an extent almost unprecedented in this country: by the 15th of September the deaths exceeded a hundred a day. In nine weeks there were 1,533 deaths from cholera in a population of 86,114, being 178 to each 10,000 inhabitants; but the greater number of these deaths occurred in a few days, as 1001 took place from the 13th to the 23rd Sept. inclusive.[20]

Gateshead, which is situated opposite to Newcastle, on the other side of the Tyne, is supplied with the same water; and in 1849 it shared with that town a comparative immunity from cholera, whilst in the autumn of 1853, 433 persons died of that disease out of a population of 26,000, or thereabouts, being 166 to each 10,000 inhabitants.

The lowest streets in Newcastle and Gateshead are about five feet above high-water mark; and only a few streets are situated at this level, for the banks rise very abruptly, at a little distance from the river, on both sides. A great portion of each town is elevated nearly 200 feet above the river, and some parts are nearly 300 feet high; yet the Water Company supplies all these districts, and all were severely visited by the cholera, which on this occasion spared no class of the community. In the districts which are most crowded, the mortality was greatest, the deaths being much more numerous in the parishes which contained a great number of tenements consisting of a single room, than in those which consisted chiefly of houses occupied by one family.[21] This, however, is quite in accordance with the principles which I am throughout endeavouring to explain. A great deal of stress is laid, very properly by the Commissioners who have reported respecting this outbreak, on the ill-arranged buildings the defective drainage, and want of privy accommodation, in Newcastle; but it must be remembered that all these evils existed in 1849, when Newcastle escaped with less cholera than most towns,—to a greater extent than they did in 1853, for many improvements had taken place in the meantime.

In consequence of a great outcry on the part of the public, who naturally connected the great fatality of cholera in some measure with the turbidity and offensive smell of the drinking-water, the Company entirely ceased to draw water from the Tyne on the 15th September; and although the Tyne water was not entirely out of the pipes for a day or two, the deaths, which had been rapidly increasing, began to diminish on the 17th, and were lessened considerably by the 20th. The following is the course of the mortality in Newcastle, in the most fatal part of the epidemic; and it began to decline at exactly the same time in Gateshead:

Sept	12	13	14	15	16	17	18	19	20	21	22	23
Deaths	38	59	90	106	114	103	103	111	85	68	82	60

The late General Board of Health directed one of their medical inspectors, Dr. Waller Lewis, to make minute inquiry as to the relative effects produced by the use of pure spring water, and that of the Water Company, during the epidemic of cholera in Newcastle; and it is much to be regretted that the inquiry was not carried out. To have conducted the inquiry through the whole of Newcastle and Gateshead would not have entailed a quarter as much labour as my investigations in Lambeth, Newington, and the Borough. Dr. Lewis called on Mr. Main, the secretary of the Water Company, and they made an inquiry in certain houses, taken at random, through three streets, and also in Greenhow Terrace, where a severe outbreak of cholera had occurred, although it was not supplied by the Company, but had what was reported to be good spring water. Dr. Lewis gave up the inquiry because he could not find two places exactly alike in all their physical conditions,—one place supplied with spring water, the other by the Company. He made no report of what he had done; but Mr. Main sent a paper on the subject of this commenced inquiry to the Pathological Society of Newcastle, an abstract of which appeared in the "Medical Times and Gazette."

By adding Greenhow Terrace to the streets partly supplied by the Company, and by including cases of cholera, fatal or otherwise, with those of mere diarrhoea, Mr. Main was able to show a result apparently in favour of the Company's water. He was good enough, however, to send me a copy of his paper, which contains the details of the inquiry as far as it extended; and I found, on perusing it, that, leaving out Greenhow Terrace, which is not supplied by the Company at all, there was no case of cholera, either fatal or otherwise, and no case, even of approaching cholera, in any house which was not supplied with the Company's water. All the deaths and all the cholera occurred in the houses having this water, whilst in the houses having, only pump water, there was simply diarrhoea. In the workhouse, supplied by the Water Company, and having five hundred and forty inmates, there were twelve cases of cholera, or approaching, cholera, and seven deaths; whilst in the military barracks, supplied from wells on the premises, and having five hundred and nineteen inmates, although there was a good deal of harmless diarrhoea, there was no cholera, nor any case of approaching cholera.

The communication of cholera by means of the water is well illustrated by the instance of Moscow, which was severely visited by that disease in 1830; but much less severely in the second epidemic. Subsequently to 1830 the greater part of the town, which is situated to the north of the Moscow river, obtained a supply of excellent water, conducted in pipes from springs at a distance; and the cholera in 1847 was chiefly confined to those parts of the town which lie to the south of the river, to which the new supply of water did not extend, and where the people had still only impure river-water to drink.[22]

The above instances are probably sufficient to illustrate the widely spread influence which the pollution of the drinking water exerts in the propagation of cholera.

After the Registrar General alluded, in the "Weekly Return" of 14th October last, to the very, conclusive investigation of the effects of polluted water in the south districts of London, there was a leading article, in nearly all the medical periodicals,[23] fully admitting the influence of the water on the mortality from cholera. It may therefore be safely concluded that this influence is pretty generally admitted by the profession. It must not be disguised, however, that medical men are not yet generally convinced that the disease is actually communicated from person to person by the morbid matter being swallowed in the drinking water, or otherwise. It used to be the custom of medical authors to speak of three kinds of causes of a disease, *viz.* predisposing, exciting, and proximate causes. The proximate causes have been given up, as being the diseases themselves; but authors still divide causes into predisposing and exciting ones. It may be remarked, however, that in treating of certain communicable diseases, the cause of which is thoroughly understood, as syphilis and the itch, predisposing causes are never mentioned; and that they are rarely alluded to in treating of small-pox, measles, and scarlet fever, whilst they continue to be appealed to in explanation of the various continued fevers.[24] Now many medical men, whilst they admit the influence of polluted water on the prevalence of cholera, believe that it acts by predisposing or preparing the system to be acted on by some unknown cause of the disease existing in the atmosphere or elsewhere. The following amongst other reasons prove, however, that opinion cannot long halt here, and that, if the effect of contaminated water be admitted, it must lead to the conclusion that it acts by containing the true and specific cause of the malady.

In my inquiries in the south districts of London I met with several instances in which persons, especially maidservants and young men, died of cholera within a few days after coming from the country to a house supplied with water by the Southwark and Vauxhall Company. The Registrar of Waterloo Road (2nd) remarked as follows on this point, on 26th August last:—“This is the third successive case of fatal cholera, where the patients have recently come from the country. Similar instances have frequently attracted the Registrar’s notice.” I found that the houses in which these cases occurred were supplied by the above-named company. The outbreak of cholera in the Baltic fleet, related at page 36, occurred within forty-eight hours after the polluted water had been taken on board. And lastly, if the contaminated water merely acted by predisposing or preparing the system to be infected by some other cause, it would be impossible to explain why nearly all the persons drinking it should be attacked together, in cases where a pump-well or some other limited supply is polluted, while the population around experience no increase of the malady.

All the evidence proving the communication of cholera through the medium of water, confirms that with which I set out, of its communication in the crowded habitations of the poor, in coal-mines and other places, by the hands getting soiled with the evacuations of the patients, and by small quantities of these evacuations being swallowed with the food, as paint is swallowed by house painters of uncleanly habits, who contract lead-colic in this way.

There are one or two objections to the mode of communication of cholera which I am endeavouring to establish, that deserve to be noticed. Messrs. Pearse and Marston state, in their account of the cases of cholera treated at the Newcastle Dispensary in 1853, that one of the dispensers drank by mistake some rice-water evacuation without any effect whatever.[25] In rejoinder to this negative incident, it may be remarked, that several conditions may be requisite to the communication of cholera with which we are as yet unacquainted. Certain conditions we know to be requisite to the communication of other diseases. Syphilis we know is only communicable in its primary stage, and vaccine lymph must be removed at a particular time to produce its proper effects. In the incident above mentioned, the large quantity of the evacuation taken might even prevent its action. It must be remembered that the effects of a morbid poison are never due to what first enters the system, but to the crop or progeny produced from this during a period of reproduction, termed the period of incubation; and if a whole sack of grain, or seed of any kind, were put into a hole in the ground, it is very doubtful whether any crop whatever would be produced.

Dr. Thiersch is of opinion, as appears by a discussion which has recently taken place at Munich, that the cholera evacuations are not at first capable of generating the disease; but that a decomposition takes place in them, and that in from six to nine days they become in a state to induce cholera. He founds this opinion on experiments which he performed by giving small quantities of the cholera evacuations to white mice. Although it is not contrary to all analogy that some change or development should take place in the cholera poison in the interval between its leaving one person and entering another, it is most probable that the fatal bowel complaint produced in white mice by Dr. Thiersch was not a specific disease, but the ordinary effect of putrefying ingesta. Many of the best attested instances of the communication of cholera are those, such as were related at the commencement of this work, where the patient is attacked in from twenty-four to forty-eight hours after first being near another patient, and although an interval of a week or so, often elapses between one case of the disease and those which follow, it is extremely probable that, in these instances, the evacuations remain the greater part of this time in a dry state on the soiled linen, without undergoing any change.

An objection that has repeatedly been made to the propagation of cholera through the medium of water, is, that everyone who drinks of the water ought to have the disease at once. This objection arises from mistaking the department of science to which the communication of cholera belongs, and looking on it as a question of chemistry, instead of one of natural history, as it undoubtedly is. It cannot be supposed that a morbid poison, which has the property, under suitable circumstances, of reproducing its kind, should be capable of being diluted indefinitely in water, like a chemical salt; and therefore it is not to be presumed that the cholera-poison would be equally diffused through every particle of the water. The eggs of the tape-worm must undoubtedly pass down the sewers into the Thames, but it by no means follows that everybody who drinks a glass of the water should swallow one of the eggs. As regards the morbid matter of cholera, many other circumstances, besides the quantity of it which is present in a river at different periods of the epidemic, must influence the chances of its being swallowed, such as its remaining in a butt or other vessel till it is decomposed or devoured by animalcules, or its merely settling to the bottom and remaining there. In the case of the pump-well in Broad Street, Golden Square, if the cholera-poison was contained in the minute whitish flocculi, visible on close inspection to the naked eye, some persons might drink of the water without taking any, as they soon settled to the bottom of the vessel.

It is not necessary to oppose any other theories in order to establish the principles I am endeavouring, to explain, for the field I have entered on was almost unoccupied. The best attempt at explaining the phenomena of cholera, which previously existed, was probably that which supposed that the disease was communicated by effluvia given off from the patient into the surrounding air, and inhaled by others into the lungs; but this view required its advocates to draw very largely on what is called predisposition, in order to account for the numbers who approach near to the patient without being affected, whilst others acquire the disease without any near approach. It also failed entirely to account for the sudden and violent outbreaks of the disease, such as that which occurred in the neighbourhood of Golden Square.

Another view having a certain number of advocates is, that cholera depends on an unknown something in the atmosphere which becomes localized, and has its effects increased by the gases given off from decomposing animal and vegetable matters. This hypothesis is, however, rendered impossible by the motion of the atmosphere, and, even in the absence of wind, by the laws which govern the diffusion of aeriform bodies; moreover, the connection between cholera and offensive effluvia is by no means such as to indicate cause and effect; even in London, as was before mentioned, many places where offensive effluvia are very abundant have been visited very lightly by cholera, whilst the comparatively open and cleanly districts of Kennington and Clapham have suffered severely. If inquiry were made, a far closer connection would be found to exist between offensive effluvia and the itch, than between these effluvia and cholera; yet as the cause of itch is well known, we are quite aware that this connection is not one of cause and effect.

Mr. John Lea, of Cincinnati, has advanced what he calls a geological theory of cholera.[26] He supposes that the cholera-poison, which he believes to exist in the air about the sick, requires the existence of calcareous[27] or magnesium salts in the drinking-water to give it effect. This view is not consistent with what we know of cholera, but there are certain circumstances related by Mr. Lea which deserve attention. He says that, in the western districts of the United States, the cholera passed round the arenaceous,[28] and spent its fury on the calcareous regions; and that it attacked with deadly effect those who used the calcareous water, while it passed by those who used sandstone or soft water. He gives many instances of towns suffering severely when river water was used, whilst others, having only soft spring water or rain water, escaped almost entirely; and he states that there has been scarcely a case of cholera in families who used only rain water. The rivers, it is evident, might be contaminated with the evacuations, whilst it is equally evident that the rain water could not be so polluted. As regards sand and all sandstone formations, they are well known to have the effect of oxidizing and thus destroying organic matters; whilst the limestone might not have that effect, although I have no experience on that point. The connection which Mr. Lea has observed between cholera and the water is highly interesting, although it probably admits of a very different explanation from the one he has given.

There are certain circumstances connected with the history of cholera which admit of a satisfactory explanation according to the principles explained above, and consequently tend to confirm those principles. The first point I shall notice, *viz.,* the period of duration of the epidemic in different places, refers merely to the communicability of the disease, without regard to the mode of communication. The duration of cholera in a place is usually in a direct proportion to the number of the population. The disease remains but two or three weeks in a village, two or three months in a good-sized town, whilst in a great metropolis it often remains a whole year or longer. I find from an analysis which I made in 1849 of the valuable table of Dr. Wm. Merriman, of the cholera in England in 1832,[29] that fifty-two places are enumerated in which the disease continued less than fifty days, and that the average population of these places is 6,624. Forty-three places are likewise down in which the cholera lasted fifty days, but less than one hundred; the average population of these is 12,624. And there are, without including London, thirty-three places in which the epidemic continued one hundred days and upwards, the average population of which is 38,123; or if London be included, thirty-four places, with an average of 78,823. The following short table will show these figures in a more convenient form:

There was a similar relation in 1849 between the duration of the cholera and the population of the places which it visited; a relation which points clearly to the propagation of the disease from patient to patient; for if each case were not connected with a previous one, but depended on

No. of Places	Duration in Days	Average Population
52	0 to 50	6,624
43	50 to 100,000	12,624
33	100 and upwards	38,123
34		78,823

some unknown atmospheric or telluric condition, there is no reason why the twenty cases which occur in a village should not be distributed over as long a period as the twenty hundred cases which occur in a large town.

Even the duration of the cholera in a street, when compared to its duration in the individual houses, points to the same conclusion. A table has been published[30] in the report of the late discussion on cholera at Munich, which shows that whilst the epidemic remained three or four weeks in a street, it only remained six or seven days in houses where several people were attacked. Dr. Pettenkofer remarks, that "if the proximate cause of the disease had been generally diffused over a certain number of streets or a certain district, and its invasion had been opposed by individual disposition alone, one might have expected that both the cases of disease and the instances of death would have occurred in single houses, where many such appeared together, at similar periods of time throughout the whole street; but, supposing that the proximate cause of the disease was not general, but local, then it would act in such a manner that the period of time within which the disease would show itself in single houses would be very different from that which was applicable to the entire street." The local cause in a house we know to be the illness of some individual, who, in many cases, has newly arrived from some place where the disease was prevailing.

Each time when cholera has been introduced into England in the autumn, it has made but little progress, and has lingered rather than flourished during the winter and spring, to increase gradually during, the following summer, reach its climax at the latter part of summer, and decline somewhat rapidly as the cool days of autumn set in. In most parts of Scotland, on the contrary, cholera has each time run through its course in the winter immediately following its introduction. I have now to offer what I consider an explanation, to a great extent, of these peculiarities in the progress of cholera. The English people, as a central rule, do not drink much unboiled water, except in warm weather. They generally take tea, coffee, malt liquor, or some other artificial beverage at their meals, and do not require to drink between meals, except when the weather is warm. In summer, however, a much greater quantity of drink is required, and it is much more usual to drink water at that season than in cold weather. Consequently, whilst the cholera is chiefly confined in winter to the crowded families of the poor, and to the mining population, who, as was before explained, eat each other's excrement at all times, it gains access as summer advances to the population of the towns, where there is a river which receives the sewers and supplies the drinking water at the same time; and, where pump-wells and other limited supplies of water happen to be contaminated with the contents of the drains and cesspools, there is a greater opportunity for the disease to spread at a time when unboiled water is more freely used.

In Scotland, on the other hand, unboiled water is somewhat freely used at all times to mix with spirits; I am told that when two or three people enter a tavern in Scotland and ask for a gill of whiskey a jug of water and tumbler glasses are brought with it. Malt liquors are only consumed to a limited extent in Scotland, and when persons drink spirit without water, as they often do, it occasions thirst and obliges them to drink water afterwards.

There may be other causes besides the above which tend to assist the propagation of cholera in warm, more than in cold weather. It is not unlikely that insects, especially the common house-flies, aid in spreading the disease. An ingenious friend of mine has informed me that, when infusion of quassia has been placed in the room for the purpose of poisoning flies, he has more than once perceived the taste of it on his bread and butter.

Dr. Farr gives the following very important information respecting the sex of persons who died of cholera at different periods of the epidemic.[31] It is worthy of remark, that at the beginning of the epidemic, the deaths of males exceeded the deaths of females very considerably; the numbers in the months of October, November, and December, 1848, were males 612, females 493; or in the proportion of 100 to 80. . . .

> *As a general rule, when the mortality from cholera attained a very high rate, the number of deaths among females exceeded the deaths among males.*
>
> *In London a remarkable change was observed in the proportion of the sexes affected in the course of the epidemic. In four weeks of October 1848, the deaths of 80 males and of 42 females by cholera were registered; in the thirteen last weeks of the year the deaths of 258 males and 210 females were registered; and there was an excess of males at all ages, but particularly in the ten years of age 15–25. In the quarter ending March 1849, the deaths of males amounted to 250, of females to 266: at the age of 25 and upwards the excess of deaths among females was considerable. In June, at the commencement of the great outbreak, the males again furnished the most numerous victims. At the close of July the females died in greater numbers than the males, and continued to do so to the end. In the week that the mortality was highest, the deaths of 895 males and of 1131 females were returned. In the September quarter the deaths of males under the age of 25 exceeded the deaths of females; but after that age the proportions were reversed.*

The greater part of the female population remain almost constantly at home, and take their meals at home, whilst a considerable number of the men move about in following their occupations, and take both food and drink at a variety of places; consequently, in the early part of an epidemic, when the disease only exists in a few spots, the male part of the population is most liable to come within the operation of the morbid poison; but at a later period of the epidemic, when the cholera is more generally diffused, it may reach those who stay at home as readily as those who move about; and in addition to the risk which the women share with the men, they have the additional one of being engaged in attending on the sick.

It is a confirmation of this view of the matter that, when the cholera poison is distributed through the pipes of a Water Company, the above rule does not hold good, but a contrary one prevails, owing, probably, to females being less in the habit of drinking beer than men, and being therefore more likely to drink water. Of the 334 deaths detailed in the Appendix to this work [Snow's appendix not included. Ed.] (286 of them amongst the customers of the Southwark and Vauxhall Water Company), only 147 were males, whilst 187 were females. The deaths occurred in the first four weeks of the recent epidemic. On the other hand, out of the 229 deaths from cholera which occurred in all the rest of London during this period, 140 were males and only 89 females. When the mortality of the whole of the metropolis during this period is taken together, there is a slight preponderance on the part of the males; the numbers being,—males 287, females 276: total 563.

The deaths from cholera in England in 1849 were 53,293; of those, 14,718, or 27 per cent. of the whole, occurred in children under 15 years of age. Of the 334 deaths which are recorded in the Appendix to this work 127, or 38 per cent., are those of children under 15, whilst of the remaining 229 which occurred in the rest of London during the first four weeks of the epidemic, only 61, or 26 per cent., took place before the age of 15,—a proportion nearly the same as in the whole of England in 1849. The higher proportion of deaths amongst children in the houses supplied with the impure water from the Thames at Battersea Fields, probably arose from the circumstance that children are very fond of drinking water in warm weather. I often heard such remarks as the following, in making my inquiries in the south districts of London:—"My children like water better than tea or anything else, I cannot keep them away from the water-butt;" or, "the child that is dead used to drink a great deal of that water, she was big enough to reach to the butt herself."

Dr. Guy, physician to King's College Hospital, made a table showing the occupations of 4,312 males, of fifteen years of age and upwards, who died of cholera in London in the epidemic of 1848–49; together with the ratio which the deaths bear to the living, as well as it could be ascertained from the census of 1841. I have not room for the whole table, but have selected the occupations which suffered most, and those which suffered least. The following abstract of Dr. Guy's table contains all the occupations where the deaths from cholera equaled one-fiftieth of the number living, and all those in which the deaths did not exceed one in two hundred and fifty living.

In some of the occupations which show a high relative mortality, the number of living is too small to allow of any reliable statistical result, and the relative mortality is probably due to accidental circumstances quite unconnected with the occupation. In other cases, however, the numbers are so considerable as to indicate something more than accident. The 299 sailors, for instance, constituted one twenty-fourth of the whole estimated number in that occupation. The 7 ballast-heavers form just the same proportion of the whole in that occupation, and the 53 coal porters and coal heavers constituted one in 32 of those so employed. Now all those persons lived or were employed on the river, where it is the habit to drink water drawn by pailfuls from the side of the ship. The 67 hawkers are one in 22 of the whole number. These persons are constantly moving about, and are in the habit of living in crowded lodging houses, and consequently must be extremely liable to contract any communicable disease. Tanners nearly all live in Bermondsey and Lambeth, supplied in 1849 with none but very impure water, as was previously explained. The weavers probably suffered the high rate of mortality from the crowding of their apartments in Spitalfields, and the uncleanness of their habits.

The persons who suffered less from cholera than any other part of the male population, are footmen and menservants; and it is impossible to conceive a class less exposed to the disease. They live in the best parts of London, and go from home much less than their masters. The low rate of mortality amongst medical men and undertakers is worthy of notice. If cholera were propagated by effluvia given off from the patient, or the dead body, as used to be the opinion of those who believed in its communicability; or, if it depended on effluvia lurking about what are by others called infected localities, in either case medical men and undertakers would be peculiarly liable to the disease; but, according to the principles explained in this treatise, there is no reason why these callings should particularly expose persons to the malady.

There is one remarkable circumstance connected with Dr. Guy's table (Table XIV). One master-brewer died of cholera, being 1 in 160 of the trade; but no brewer's man or brewer's servant is mentioned as having died of this malady, although these men must constitute a very numerous body in London. There must be a few thousands of them. I have, indeed, met with the deaths of two or three of these persons, in looking over the returns of some of the most fatal weeks in 1849; but the brewers' men seem to have suffered very slightly both in that and the more recent epi-

Table XIV

	No. of Deaths	Ratio
Agents	12	1 in 49
Brick layers and builders	14	1"39
Cow-keepers, dairymen, and milkmen	8	1"20
Egg merchants	5	1"6
Fishmongers	11	1"20
Fruiterers and green-grocers	12	1"28
Jobmasters, livery-stable keepers	5	1"37
Oilmen	13	1"46
Paper-makers	2	1"15
Poulterers	3	1"32
Sail-makers	2	1"30
Turners	2	1"50
Ballast-heavers	7	1"24
Coal-porters and coal-heavers	53	1"32
Dustmen and scavengers	6	1"39
Founders	10	1"12
Hawkers, etc.	67	1"22
Lithographers	3	1"48
Modelers	3	1"41
Polishers	4	1"36
Sailors, including Greenwich pensioners	299	1"24
Tanners	22	1"39
Weavers	102	1"36
Physician, surgeons, & general practitioners	16	1"265
Magistrates, barristers, conveyancers, and attorneys	13	1"375
Merchants	11	1"348
Auctioneers	1	1"266
Saddlers	1	1"250
Brass-finishers	3	1"318

(*continued*)

Table XIV *(continued)*

	No. of Deaths	Ratio
Coach-makers	16	1"262
Cork-cutters	2	1"279
Footmen and men-servants	25	1"1572
Jewelers, goldsmiths, and silversmiths	6	1"583
Millwrights	2	1"266
Tallow-chandlers	2	1"430
Type-founders	1	1"390
Undertakers	2	1"325
Warehousemen	8	1"472
Watchmakers	11	1"364
Wheelwrights	8	1"294

demics. The reason of this probably is, that they never drink water, and are therefore exempted from imbibing the cholera poison in that vehicle.

The great prevalence of cholera along the course of rivers has been well known for a quarter of a century; and it meets with a satisfactory explanation from the mode of communication of the disease which I am inculcating. Rivers always receive the refuse of those living on the banks, and they nearly always supply, at the same time, the drinking water of the community so situated. It has sometimes been objected to the propagation of the disease by the water of rivers, that the epidemic travels as often against the stream as with it. The reply to this is, that people travel both against the stream and with it, and thus convey the malady from village to village and from town to town on the banks, whilst the water serves as a medium to propagate the disease amongst those living at each spot, and thus prevents it from dying out through not reaching fresh victims.

The principles I have laid down afford a satisfactory explanation of the circumstances, that absence of drainage promotes the prevalence of cholera, and that it flourishes better on a clay soil than on primitive rocks, sandstone, or gravel. Without drainage, the refuse of the population permeates the ground, and gains access to the pump-wells. Merthyr Tydvil, with 52,863 inhabitants, is entirely without drainage, and the people derive their supply of water from pump-wells. This place has suffered severely from cholera in every epidemic. In 1849 there were 1,682 deaths from this disease, being 234 to each 10,000 inhabitants,—a rate of mortality as high as in Hull and certain of the south districts of London, where the morbid poison of cholera was distributed by the steam-engines of the water companies. The primitive rocks, sandstone, and gravel, generally cause the purification of the water by the separation or oxidation of organic matters, whilst clay does not exert this salutary influence to the same extent.

Since the latter part of 1848, when I first arrived at my present conclusions respecting the mode of communication of cholera, I have become more and more convinced that many other diseases are propagated in the same way.

When the plague visited this country, it was most fatal in London, York, Winchester, and certain other towns having a river of fresh water passing through them. It resembled cholera also in being twice as fatal in the districts on the south of the Thames as in those on the north. The following passage from Stow's "Survey," published in 1633, shows the way in which Southwark was supplied with water about the time of the great visitations of plague: "Southwark useth chiefly the water of the Thames, that falls into a great pond at St. Mary Overies, that drives a mill called St. Saviour's Mill, the owner whereof is one Mr. Gulston. The revenue thereof is supposed by some to be worth 1,300£ a year."

Although some of the lower parts of the City were supplied with water from the Thames, at the latter part of the sixteenth and throughout the seventeenth century, yet the greater part of London north of the Thames was supplied by fountains and conduits, conveying spring water from a distance. The following quaint but poetic account of the conduits of London cannot fail to be interesting. "As nature, by veins and arteries, some great and some small, placed up and down all parts of the body, ministereth blood to every part thereof; so was that wholesome water, which was necessary for the good of London, as blood is for the good and health of the body, conveyed by pipes, wooden or metalline, as by veins, to every part of this famous city. . . . They were lovely streams indeed that did refresh that noble city, one of which was always at work pouring out itself when the rest lay still. Methinks these several conduits of London stood like so many little but strong forts, to confront and give check to that great enemy, fire, as occasion should be. There, methinks, the water was entrenched and in-garrisoned. The several pipes and vehicles of water that were within these conduits, all of them charged with water, till by turning of the cock they were discharged again, were as so many soldiers within these forts, with their musketry charged, ready to keep and defend these places. And look how enemies are wont to deal with these castles, which they take to be impregnable, and despair of ever getting by them,—that is, by attempting to storm them by a close siege: so went the fire to work with these little castles of stone, which were not easy for it to burn down (witness their standing to this day); spoiled them, or almost spoiled them, it hath for the present, by cutting off those supplies of water which had vent to flow to them, melting those leaden channels by which it had been conveyed, and thereby, as it were, starving those garrisons which it could not take by storm. As if the fire had been angry with the poor old tankard-bearers, both men and women, for propagating that element which was contrary to it, and carrying it upon their shoulders, as it were, in state and triumph, it hath even destroyed their trade, and threatens to make them perish by fire who had wont to live by water."[32]

Dr. Farr makes the following remarks on the plague, in his report on the cholera of 1848–9: "It is endemic in the Delta of the Nile, and periodically decimates the population of Cairo and Alexandria. . . . It grows gradually less fatal up the Nile, and is less frequent and destructive in Upper than in Lower Egypt, in the high lands and in the desert, than on the low lands on the shores of the Mediterranean." Speaking of Cairo, he says: "Through the midst of it passes the Great Canal, into which the sewers are discharged over carrion, excretion, and mud. At the yearly overflow of the Nile, its waters, filling this canal, are distributed over the city and drunk by its wretched inhabitants."

The plague resembles cholera in being much promoted by crowding and want of personal cleanliness. The natives of Gurhwal, a province in the northwest of British India, in which the plague has been present for the last thirty years, believe that it may be transmitted from one place to another in articles of diet, such as a jar of ghee.[33]

Yellow fever, which has been clearly proved by Dr. M. William and others to be a communicable disease, resembles cholera and the plague in flourishing best, as a general rule, on low alluvial soil, and also in spreading greatly where there is a want of personal cleanliness. This disease has more than once appeared in ships sailing up the river Plate, before they have had any communication with the shore. The most probable cause of this circumstance is, that the fresh water of this river, taken up from alongside the ship, contained the evacuations of patients with yellow fever in La Plata or other towns.

It was long, ago observed, that dysentery was apparently propagated by the drinking of water containing excrementitious matters.[34] The frequent appearance of this disease in Millbank prison, when the Thames water was used, is a confirmation of this; and Dr. Bryson has lately related a number of instances where both dysentery and fever seemed to be occasioned by the water of the Yangtse-Kiang, the Canton river, and other rivers of China.[35] What very much confirms this view of the case, is, that nearly all the patients were afflicted with great numbers of intestinal worms (*lumbrici*); for it cannot be supposed that the worms could proceed from malaria, miasmata, or any of the causes which are frequently believed to occasion dysentery and fever. The eggs of the lumbrici were no doubt contained in great numbers in the water of the densely populated Chinese rivers.

There are many facts which indicate that one at least of the continued fevers—the typhoid fever with ulceration of the small intestines—is also propagated in the same way as cholera. Dr. Jenner called my attention some time ago to an instance occurring at the village of North Boston, Erie County, N.Y., in which typhoid fever was probably communicated to a number of families by the contamination of the water of a well which they used.[36] The epidemic which prevailed so extensively at Croydon two years ago was of this character, as was verified by a Committee of the Epidemiological Society, of which Drs. Sankey, Jenner, and A. P. Stewart were members. Mr. Carpenter, of Croydon, has lately shown very ably that this epidemic was connected with the pollution of the pump-wells of the town, giving, to the disturbance of the ground, and of many old cesspools during the drainage operations of the Local Board of Health.[37] The Board had supplied the town with good water from a deep well in the chalk, but the population had a prejudice against it and persisted in resorting to the water of the shallow pump-wells. In the autumn of last year diarrhoea was very prevalent in Croydon, and Mr. Carpenter found that this also was caused by the impure water of the pump-wells. Nine-tenths of the people of Croydon were drinking the new water supplied by the Board of Health, but, out of thirty-two patients with diarrhoea who came under the notice of Mr. Carpenter, twenty-five were drinking well-water entirely, five drank water from both sources, and the other two could not decidedly say that they had not drank well-water.

Intermittent fevers are so fixed to particular places that they have deservedly obtained the name of endemics. They spread occasionally, however, much beyond their ordinary localities, and become epidemic. Intermittent fevers are undoubtedly often connected with a marshy state of the soil; for draining the land frequently causes their disappearance. They sometimes, however, exist as endemics, where there is no marshy land or stagnant water within scores of miles. Towards the end of the seventeenth century, intermittent fevers were, for the first time, attributed by Lancisi to noxious effluvia arising from marshes. These supposed effluvia, or marsh miasmata, as they were afterwards called, were thought to arise from decomposing vegetable and animal matter; but, as intermittent fevers have prevailed in many places where there was no decomposing vegetable or animal matter, this opinion has been given up in a great measure; still the belief in miasmata or malaria of some kind, as a cause of intermittents, is very general. It must be acknowledged, however, that there is no direct proof of the existence of malaria or miasmata, much less of their nature.

That preventive of ague, draining the land, must affect the water of a district quite as much as it affects the air, and there is direct evidence to prove that intermittent fever has, at all events in some cases, been caused by drinking the water of marshes. In the "General Report of the Poor Law Commissioners on the Sanitary Condition of Great Britain,"[38] Mr. Wm. Blower, surgeon, of Bedford, states that typhus and ague, which had long infested the village of Wootton, near Bedford, had been much diminished by digging a few wells, and obtaining good water. He also states that, in the neighbouring parish of Houghton, almost the only family which escaped ague, at one time, was that of a respectable farmer who used well water, whilst all the other families had only ditch water.

M. Boudin[39] relates a very marked instance in which intermittent, and apparently also remittent, fever were caused by drinking marsh water. It is as follows:

> *In July 1834, 800 soldiers, all in good health, embarked on the same day in three transports at Bona, in Algeria, and arrived together at Marseilles; they were exposed to the same atmospheric influences, and were, with one essential difference, supplied with the same food, and subjected to the same discipline. On board one of the vessels were 120 soldiers: of these, 13 died on the passage, from a destructive fever, and 98 more were taken to the military hospital of the lazaretto at Marseilles presenting all the pathological characters proper to marshy localities. On seeing, the physiognomy of these patients altogether so unusual for Marseilles, one would have said that the Gulf of Mexico, the Delta of the Ganges, and the marshes of Senegal and of Holland, had supplied passengers to this ship. In short, by the side of a simple intermittent, there was a pernicious fever. On an inquiry being instituted, it was ascertained that on board the affected ship the water supplied for the soldiers, owing to the haste of the embarkation, had been taken from a marshy place near Bona; whilst the crew, not one of whom was attacked, were supplied with wholesome water. It further appeared that the nine soldiers who had escaped had purchased water of the crew, and had consequently not drunk the marsh water. Not a single soldier or sailor of the other two transports, who were supplied with pure water, suffered.*

Mr. Grainger, who quotes the above circumstance in his Appendix to the Report on Cholera, also says,[40] "Dr. Evans, of Bedford, related to me an equally well-marked instance. A few years ago, he was staying at Versailles, with his lady, when they both became affected with the ague, and, on inquiry, the following facts were disclosed. The town of Versailles is supplied with water for domestic purposes from the Seine, at Marli. At the time in question, a large tank, supplying one particular quarter, was damaged, and the mayor, without consulting the medical authorities, provided a supply of water, consisting of the surface-drainage of the surrounding country, which is of a marshy character. The regular inhabitants would not use this polluted water; but Dr. and Mrs. Evans, who were at a hotel, drank of it unwittingly and it was also used by a regiment of cavalry. The result was, that those who drank the water suffered from intermittent fever of so severe a type that seven or eight of the soldiers, fine young men, died on one day, Sept. 1, 1845. On a careful investigation it was ascertained that those only of the troops who had drunk the marsh water were attacked; all the others, though breathing the same atmosphere, having escaped, as did also the townspeople."

In all the instances I have just quoted, the cause of ague, whatever it may be, was swallowed with the water, not inhaled with the air; and on questioning two patients, ill with this complaint, in St. George's Hospital, after harvesting in Kent, they told me that they had often been obliged to drink water from the ditches. The disease of the liver and spleen, to which persons are subject after attacks of intermittent fever, also confirms the view that its material cause enters the system by the alimentary canal, and not by the lungs; and it is of importance to remark, that Hippocrates observed, that drinking stagnating waters caused hard swellings of the spleen.[41]

Whether the unknown cause of ague has been produced in the system of a previous patient, like the pus of small-pox and the eggs of tape-worm, or whether it has been produced externally, there is, at present, no sufficient evidence to show. In the case first supposed, the disease would be a communicable one, in the second it would not.

There is one circumstance which seems to indicate that the specific cause of intermittent fevers undergoes a development or multiplication within the system of the patient,—it is, that a period of dormancy or incubation, has been observed, in many cases, between the visit to the unhealthy locality and the illness which followed; for, as I have already remarked, every poisonous or injurious substance causes symptoms as soon as it has been absorbed in sufficient quantity.

The communication of ague from person to person has not been observed, and supposing this disease to be communicable, it may be so only indirectly, for the *materies morbi* eliminated from one patient may require to undergo a process of development or procreation out of the body before it enters another patient, like certain flukes infesting some of the lower animals, and procreating by alternate generations.

The measures which are required for the prevention of cholera, and all diseases which are communicated in the same way as cholera, are of a very simple kind. They may be divided into those which may be carried out in the presence of an epidemic, and those which, as they require time, should be taken beforehand.

The measures which should be adopted during the presence of cholera may be enumerated as follows:—

1st. The strictest cleanliness should be observed by those about the sick. There should be a hand-basin, water, and towel, in every room where there is a cholera patient, and care should be taken that they are frequently used by the nurse and other attendants, more particularly before touching any food.

2nd. The soiled bed linen and body linen of the patient should be immersed in water as soon as they are removed, until such time as they can be washed, lest the evacuations should become dry, and be wafted about as a fine dust. Articles of bedding and clothing which cannot be washed, should be exposed for some time to a temperature of 212° or upwards.

3rd. Care should be taken that the water employed for drinking and preparing food (whether it come from a pump-well, or be conveyed in pipes) is not contaminated with the contents of cesspools, house-drains, or sewers or, in the event that water free from suspicion cannot be obtained, is should be well boiled, and, if possible, also filtered.

Works are in progress for supplying a great part of London with water from the Thames, obtained, like that of the Lambeth Company, above Teddington Lock. Although this is not the best possible source for supplying a large town, it is a great improvement on the practice of many of the water companies; and the water, owing to filtration, and especially to its detention in large reservoirs, will probably be quite salubrious: at all events it will be much safer than that of the shallow pump-wells of London, which are fed from very polluted sources. It is very desirable that the handles of nearly all the street pumps of London and other large towns should be fastened up, and the water used only for such purposes as watering the streets. A proper supply of water for the shipping in the Thames is much wanted. Water acquires a flat taste by being boiled; but if it is filtered after it becomes cold, it gets re-aerated, and the flat or vapid taste is entirely removed.

4th. When cholera prevails very much in the neighbourhood, all the provisions which are brought into the house should be well washed with clean water, and exposed to a temperature of 212°F.; or at least they should undergo one of these processes, and be purified either by water or by fire. By being careful to wash the hands, and taking due precautions with regard to food, I consider that a person may spend his time amongst cholera patients without exposing himself to any danger.

5th. When a case of cholera or other communicable disease appears among persons living in a crowded room, the healthy should be removed to another apartment, where it is practicable, leaving only those who are useful to wait on the sick.

6th. As it would be impossible to clean out coal-pits, and establish privies and lavatories in them, or even to provide the means of eating a meal with anything, like common decency, the time of working, should be divided into periods of four hours instead of eight, so that the pitmen might go home to their meals, and be prevented from taking, food into the mines.

7th. The communicability of cholera ought not to be disguised from the people, under the idea that the knowledge of it would cause a panic, or occasion the sick to be deserted. British people would not desert their friends or relatives in illness, though they should incur danger by attending to them; but the truth is, that to look on cholera as a "catching" disease, which one may avoid by a few simple precautions, is a much less discouraging doctrine than that which supposes it to depend on some mysterious state of the atmosphere in which we are all of us immersed and obliged to breathe.

The measures which can be taken beforehand to provide against cholera and other epidemic diseases, which are communicated in a similar way, are—

8th. To effect good and perfect drainage.

9th. To provide an ample supply of water quite free from contamination with the contents of sewers, cesspools, and house-drains, or the refuse of people who navigate the rivers.

10th. To provide model lodging-houses for the vagrant class, and sufficient house room for the poor generally.

The great benefit of the model lodging-houses arises from the circumstance that the apartments for cooking, eating, and sleeping, are distinct, and that all the proper offices which cleanliness and decency require are provided. The very poor who choose to avail themselves of these institutions, suffer a rate of mortality as low as that of the most opulent classes. The public wash-houses, which enable poor persons to wash the soiled linen of the sick or the healthy, without doing it in the midst of the plates and dishes and provisions of the family, are well calculated to prevent the spread of disease.

11th. To inculcate habits of personal and domestic cleanliness among the people everywhere.

12th. Some attention should undoubtedly be directed to persons, and especially ships, arriving from infected places, in order to segregate the sick from the healthy. In the instance of cholera, the supervision would generally not require to be of long duration.

In the autumn of 1853, certain German emigrants, on their way to America, who had crossed the sea from Hamburgh and Rotterdam, where cholera was prevailing, to the port of Hull, and had gone thence, by rail, to

Liverpool, were seized with cholera (some of them fatally) in the latter town; and it is most likely to the well-regulated Emigrant's Home, in which these cases occurred, that the town of Liverpool owed its freedom from the epidemic at that time. And a little medical supervision, and the detention of some of the emigrants for a short time in Liverpool, before their embarcation, would probably have prevented the great mortality, which occurred in some of the emigrant ships during their passage to America.

The measures which are intended to prevent disease should be founded on a correct knowledge of its causes. For want of this knowledge, the efforts which have been made to oppose cholera have often had a contrary effect. In 1849, for instance, the sewers of London were frequently flushed with water,—a measure which was calculated to increase the disease in two ways: first, by driving the cholera evacuations into the river before there was time for the poison to be rendered inert by decomposition and second, by making increased calls on the various companies for water to flush the sewers with,—so that the water which they sent to their customers remained for a shorter time in the reservoirs before being distributed. It should be remarked, also, that the contents of the sewers were driven into the Thames by the flushing, at low water, and remained flowing up the stream for four or five hours afterwards. Flushing the sewers was not repeated during the recent epidemic, but increased quantities of water were distributed by some of the Companies, and at more frequent intervals, causing the water-butts to overflow for hours together into the drains, and producing nearly the same effect as flushing the sewers; in addition to which, the water in the butts of the Southwark and Vauxhall Company's customers was prevented from settling, as it might have done if less frequently disturbed.

I feel confident, however, that by attending to the above-mentioned precautions, which I consider to be based on a correct knowledge of the cause of cholera, this disease may be rendered extremely rare, if indeed it may not be altogether banished from civilized countries. And the diminution of mortality ought not to stop with cholera. The deaths registered under the name of typhus consist chiefly of the typhoid fever mentioned above. Its victims are composed chiefly of persons of adult age, who are taken away from their families and connections. In 1847 upwards of 20,000 deaths were registered in England from typhus, and in 1848 upwards of 30,000 deaths. It is probable that seven times as many deaths have taken place from typhus as from cholera, since the latter disease first visited England in 1831; and there is great reason to hope that this mortality may in future be prevented by proper precautions, resulting from a correct knowledge of the mode of communication of the malady.

[Snow's volume also contains maps and a 25-page appendix that lists "the number of deaths from cholera registered in the four weeks ending 5th August, 1854, together with the supply of water in the houses in which the fatal attacks took place, in all the sub-districts to which the water supply of either the Southwark and Vauxhall or the Lambeth Company extends. (See Table vii, page 84.) The registers of deaths are copied from the weekly Returns of the Registrar General." Ed.]

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CHAPTER 13

EDWARD JARVIS
(1803–1884)

It's a mad world. Mad as Bedlam.

—CHARLES DICKENS, *David Copperfield*, 1849–1850

Insanity runs in my family. It practically gallops.

—CARY GRANT, *Arsenic and Old Lace*, 1944

AMONG THE MORE INTRIGUING FOUNDERS of the American public health movement, Edward Jarvis was born in Concord, Massachusetts, on January 9, 1803. The fourth child of an independent farmer and baker, Deacon Francis Jarvis, and Milicent Hosmer Jarvis, Edward Jarvis was at first directed to learn a trade. Only when deaths in the family opened opportunities did Jarvis receive any education, first in Concord, then Westfield, and finally Harvard College, from which he received a B.A. degree in 1826. Although he first considered becoming a clergyman, Jarvis decided on medicine for his career and earned an M.D. degree from Harvard University in 1830. After practicing for two years in Northfield, Massachusetts, Jarvis returned to Concord in 1832. He remained there until 1837. It was during 1832–1837 that Jarvis's interests in vital statistics and psychiatry emerged. In 1836, he began publishing on psychiatric subject matter, though his practice did not prosper.

In 1837, Jarvis moved to Louisville, Kentucky, where he opened a private medical practice. He found himself at odds with the pro-slavery sentiments of the area, and his business once again did not thrive. In 1842, he journeyed back to Massachusetts, settling in Dorchester. There he established a small, private asylum, which he directed until 1867. Jarvis continually applied for superintendent positions at asylums around Massachusetts, though he was never selected for any of them.

In 1844, Jarvis joined the nascent American Statistical Association. He soon became its vice president and then president. The latter position, begun in 1852, is one he occupied for 32 years, making him the longest-serving president in the Association's history. One of Jarvis's key accomplishments during his presidency was developing close ties between the Association and the U.S. Census Bureau (USCB). Those ties continue to the present day.

Jarvis's involvement with the USCB began with his criticism of the health questions used in the 1840 census. In time, he not only worked with the USCB on improving the census but served on the advisory committee appointed to overhaul the census. He continued in this role for almost two decades.

Given Jarvis's expertise in statistics and his interest in psychiatry, it is not surprising he was appointed by the governor of Massachusetts to the state's Lunacy Commission in 1854. Using this position, Jarvis wrote an exemplar report on the state of the mentally ill in Massachusetts. In 1860, Jarvis traveled to Europe, visiting asylums and attending the International Statistical Congress. Three years later, Jarvis was appointed to inspect military hospitals in the United States.

Although much is known about Jarvis's life prior to 1842, until which time he maintained a diary, details of his later life are less clear. He died in Dorchester, Massachusetts, on October 31, 1884.

A Note on the Text

The reading selection comes from Jarvis's 1855 report on mental hygiene in the Commonwealth of Massachusetts. In many respects, it bears a strong relation to Shattuck's sanitary survey, owing to Shattuck's influence on Jarvis in the 1830s and 1840s.

The report on lunacy was the first of its kind in the United States. In it, Jarvis methodically conducts a census of residents of all the asylums in the Commonwealth. He notes the problem of diagnosis and ascertainment. If an individual has not been placed in an asylum, then that case will not be incorporated into his census. However, that does not diminish the significance of that case, merely that the data compiled may reflect underascertainment. This problem has persisted for the past 150 years—and not just in mental hygiene matters.

Jarvis then considers the probity of the data. Were the reports accurate? He notes the similarity of facts presented when two individuals identified the same case. Most of the data came from physicians, and Jarvis felt such professionals were the best persons to afford the diagnoses associated with mental illness in an individual patient.

Given reliable data, what exactly are the numbers of the insane in the Commonwealth? Jarvis begins presentation of the results of the census with "lunatics" followed by "idiots." To provide some basis for appreciating the meaning of these data, he offers a comparison with previous surveys. England and France appear to be the only places in which previous surveys were undertaken (perhaps this is why Jarvis visited them specifically when he traveled to Europe in 1860).

Significantly, Jarvis concludes his introduction with a focus on the costs associated with mental illness in the Commonwealth. He notes that the direct costs are the indirect ones, specifically the anguish of families. However, Jarvis does not offer the full argument for prevention—that is, the cost of preventing the disease will likely be less than that of treating it. It is possible that in mid-nineteenth-century America, with physicians struggling to maintain their practices, the cost of prevention was perceived as less lucrative that the cost of care. Jarvis may have raised the issue of emotional cost to justify efforts that went beyond the costs of treating those already in the asylums of Massachusetts.

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Insanity and Idiocy in Massachusetts—Report of the Commission on Lunacy, 1855

House—No. 144.
Commonwealth of Massachusetts

To his *Excellency* Henry J. Gardner, *Governor, and the Honorable the Council of the Commonwealth of Massachusetts*:—

The undersigned, the Commissioners appointed under the Resolve of the Legislature of 1854, "concerning the Insane in this Commonwealth, and the State Lunatic Hospital of Worcester," respectfully

Report

The Resolves by which their commission was created required of them,—

1. "To ascertain the number and condition of the insane in the State, distinguishing as accurately as may be between the insane, properly so considered, and the idiotic or *non compos*; between the furious and the harmless, curable and incurable, and between the native and the foreigner, and the number of each who are State paupers."
2. "To examine into the present condition of the Hospitals of the State for the insane, and see what number of patients can properly, with due regard to their comfort and improvement, be accommodated in said Hospitals."
3. "To see what further accommodations, if any, are needed for the relief and care of the insane."
4. "And, generally, to examine and report the best and most approved plans for the management of the insane, so far as the size and character of Hospitals, and the number of patients proper to be under one supervision are concerned."
5. "To examine into the present condition of the State Lunatic Hospital at Worcester, and ascertain what kind and amount of repairs are needed, and at what probable cost, and consider the expediency of disposing of the said Hospital and the lands connected therewith, or any part thereof, and of recommending a site for the erection of a new Hospital or Hospitals."
6. "To report the estimated proceeds of the sale of the present Hospital and the grounds therewith connected at Worcester, if they deem such a sale desirable."

7. "To accompany their Report with plans, specifications and estimates of cost of any new Hospital which they may recommend."

As early as possible after receiving their appointment, the Commissioners addressed themselves to the work assigned them by the Legislature.

On careful consideration of the language and spirit of the Resolves and the purposes of the Legislature in reference to this matter, they thought that the number and condition of the insane in the State, their prospects and their wants, lay at the foundation of all further action, and that therefore this inquiry should be first made. They then determined to make the requisite enumeration of the insane and idiots, and ascertain all the facts concerning them specified in the law, as the first step in their work, before they should proceed to the others, except so far as they might be attended to incidentally, while in pursuit of the first object.

In order "to ascertain the number and condition of the insane and idiots in this Commonwealth," it was necessary either to visit every family, in person or by proper agents, to make the inquiry, or to obtain the facts of those who already knew them. The former, the personal inquiry from house to house, if done by the Commissioners, would probably require some years to accomplish this object; and if done by others, it would require the aid of so many as to make the work exceedingly expensive. And moreover, it is not probable that the facts could be thus ascertained by the inquiry of agents at the doors of the several families through the State; for most people, whose friends or relatives are disordered in mind or deficient in intellect, are unwilling to talk about it, and many would be still more unwilling to confess these painful and disagreeable facts and circumstances in their domestic relations, to a stranger. And if that inquiry were made by a public officer or agent of the government who had no personal claim upon their confidence, and who sought these facts apparently to be used in a public report, many of them would undoubtedly refuse to give the information required.

In 1850, the marshals, the agents of the National Government who were appointed to take the census, visited every family; and, among other items of information, they asked for the insane and idiots in the household.

By this personal and official inquiry, made of some responsible member of every family, the marshals obtained the account of only sixteen hundred and eighty insane persons and seven hundred and ninety-one idiots, which is but little more than two-thirds of the number ascertained by this Commission.

Making all due allowance for the increase of population, and consequently of the insane and idiots, these figures undoubtedly show far less than the real amount of insanity and idiocy at that time, and render it extremely probable, that many concealed the facts that the law required them to state to the marshals.

Plan of the Inquiry-Physician Employed

In view of these difficulties, of making the inquiry from each family, the Commissioners sought out other plans. They considered that there are very few families that are not within the personal knowledge of some practitioner of medicine, and that therefore the whole Commonwealth is, in detail, under the eye of the medical profession; and that they, knowing the domestic condition of the whole people, were of course acquainted with all those whose minds were disordered or defective.

Accordingly the Commission determined to address every physician in the State, asking each to give information relative to the persons and condition of all the lunatics and idiots within his own knowledge. They sent a lithograph letter, stating the several objects of the inquiry, and enclosed a printed schedule or form of return, which contained all the heads under which the answers were to be recorded. They asked for the name, sex, color, age, country of birth, whether single, married or widowed, whether lunatic or idiot, present and usual condition, whether mild, manageable, troublesome, excitable, furious or dangerous, whether subject for a hospital or not, length of disease, if periodical the number of attacks, whether curable or not, whether the remedial influences of any hospital had ever been tried for restoration, where resident if not in the town of the reporter, and whether State or town pauper, or independent.

It was supposed that these fifteen questions would elicit all the information which the Legislature required, all that science would desire, and all that could be conveniently obtained from those of whom the inquiry was made.

Although every family was presumed to come under the cognizance of some physician, as most families have one, who attends them in their sickness, yet there are some whose various members employ two or more physicians to heal them. Each of these might observe and return the same lunatic or idiot member of the family, who would thus be reported more than once. Therefore the names were asked to enable the Commissioners to correct any mistake that might arise from this double or multiplied reporting. In course of the inquiry this has happened in many instances. With a view of this liability, the several reports from the same towns have always been compared, and the error of counting the same person more than once prevented.

To save the feelings of patients or friends who would be pained if their individual cases were told abroad, and to save the physicians from any violation of implied professional confidence, a pledge was given that none but the Commission should see the names of the persons reported. And in fulfillment of this promise, after the reports were compared and corrections made for the duplications, the names were erased.

As in sixteen towns in the State there are no physicians, letters were sent to the clergymen, on the supposition that they were acquainted with the condition of all the families; and also the overseers of the poor were asked to return the paupers; and besides these, the physicians of the neighboring towns who attended the sick in these places were especially asked to return any insane and idiots who might be in the families of the towns not their own.

Besides, similar letters and schedules were sent to the Superintendents of the Lunatic Hospitals on Worcester, Taunton, Somerville and Boston, to the officers of the county receptacles for the insane in Cambridge and Ipswich, and personal inquiry was made of the masters of all the Houses of Correction and Jails in the State, and of the proprietors of all the private houses or establishments devoted to the care of the insane, asking each to make a similar return of the lunatics and idiots under his care. And in order to complete this survey, letters were sent to officers of all the hospitals in the Northern and Middle, and some of the Southern States, asking them to make returns of all the insane patients belonging to Massachusetts who were entrusted to their charge.

By this means the Commissioners believed, that they should be able to reach nearly every insane and idiotic person who belonged to Massachusetts, and to reveal the sum of mental disorder or deficiency resting upon the children, citizens and wards of this Commonwealth, more completely than they could in any other way.

These letters were sent out in July and August, and were very kindly received. The physicians generally gave the work their ready sympathy and cooperation. The leading members of the medical profession encouraged and aided it. The Councillors of the Massachusetts Medical Society voted to approve the work and the plan of its operation, and advised all the members of the society to assist in the inquiry, and lend their influence to persuade all others to do the same. The County Societies which held their meetings within the period of this survey gave it their active assistance; and officers of every other society which did not meet gave their active and earnest help to this work within their respective spheres.

The Commissioners are also especially indebted to several physicians in the various parts of the State, who were indefatigable in their cooperation. They visited their neighboring towns; they wrote to, and used their personal influence with, the tardy brethren of their vicinity; and were ready to render any aid which the Commission, from time to time, might ask of them, to persuade the slow or the unwilling to answer the inquiry made of them.

Besides these, the Commission received assistance, from the hands of gentlemen out of the profession, in several towns where aid was wanted.

And in all the towns, where their evidence seemed to be needed, the selectmen and the overseers of the poor rendered free and acceptable service in the work.

In the four western counties, and also in Worcester, Essex, Norfolk, Bristol, and in Barnstable County especially, the Commission received great aid from the newspapers, whose liberal editors urged upon the physicians and others to answer this call, and make complete returns of all the lunatics and idiots within their respective spheres of observation.

It was unfortunate for the immediate success of this inquiry that it was made in July, August and September, the most sickly season, when the physicians are the most intensely occupied and burdened with the greatest anxiety in the care of acute and dangerous diseases. Notwithstanding this, a great majority answered within the time prescribed; but yet there were many whose professional labors and cares prevented their doing so as early as was desired; and some thus overlooked and forgot the letter, and needed again to be reminded.

In order to create a further and more active interest in the work, one of the Commissioners visited the districts where new influence seemed to be needed, and had personal interviews with the physicians in sixty-four towns who had, thus far, failed to make the returns.

These circulars were sent to

Physicians within the State	1,556
Clergymen	20
Overseers of the Poor	74
Selectmen	4
Other gentlemen	5
Superintendents of Hospitals and private establishments in the State	6
Masters of County Receptacles, Houses of Correction, Jails, and State Almshouses	11
Superintendents of Hospitals in other States	14
Personal inquiry made of other Masters of Houses of Correction and Jailers	12

The names of the physicians were taken from the catalogues of the County Societies, and from the list in Mr. Adam's State Register, as furnished to him by the town clerks. But it was ascertained that two hundred and thirty-seven of these physicians were either dead, or not in practice, or had removed away, or were unreliable. From these, then, no answers were expected, leaving thirteen hundred and nineteen who had opportunities of observation, or whose testimony was reliable, and from whom reports were therefore desired.

All of these thirteen hundred and nineteen physicians, except four, made reports directly or indirectly to the Commission. Most of them reported singly; but in many towns two or more acted in concert, and sent their facts in one letter and through one of their number.

Two regular physicians only refused to make any report, and two irregular practitioners have neglected to make returns; but the fields of observation of all these gentlemen were very carefully examined by their more willing or more intelligent neighbors, and extraordinary pains were taken to obtain collateral information from the overseers of the poor and other municipal authorities; and thus their towns were thoroughly examined, and every lunatic and idiot within their borders is presumed to be returned.

Three of four of the clergymen had removed; but others of their own profession or the town authorities answered for them; the rest made the returns.

All the overseers of the poor answered except those in four towns; in these the selectmen were addressed, and answers obtained.

In this survey the Commission placed their first and almost exclusive reliance of the physicians in the towns where they lived, and on the clergymen and overseers of the poor; but wherever there was any apparent deficiency, they sought information from other sources. After the medical returns had been made and the survey completed, the number of pauper idiots and lunatics thus received was compared with the State Report relating to the poor, published by the Secretary of State, and including the number of idiots and insane returned by the overseers of the poor, as relieved or supported within the year, and it was discovered that in forty-five towns the numbers in the overseers' report exceeded those in the medical returns. A new correspondence was then opened with these public functionaries, and resulted in the proof that, with the exception of four or five towns, the physicians had reported all the pauper insane and idiots that existed at the moment when they made their returns.

Notwithstanding the ready cooperation of a large part of the medical profession and the efficient aid rendered from others, yet it was necessary to write again and again to many, and to visit and confer with and persuade others, in various parts of the State, so that the returns were not all received until the end of December.

Reliableness of the Reports

The facts in respect to the number and condition of the insane and idiots in Massachusetts which have been received through these channels, and which are embodied in this report, derive unquestionable authority from the number, character and position of the witnesses who have testified concerning them. These statements are not the estimates drawn from general observation, nor are they, either totally or in part, calculations founded on some facts; but they are the evidence of fourteen hundred and fifty-one witnesses, each of whom testified to that which he knew and spoke of that which he had seen. Where two or more reported the same cases independently of each other, there was such an agreement of statements as manifested that honest and intelligent men had observed and were speaking of the same facts. Nearly all of these witnesses are the physicians who are living in every town and in almost every neighborhood. They understand the nature of defective or diseased minds, and are competent to testify. They are in the habit of frequent and familiar intercourse with the families, and have therefore the best possible opportunities of knowing the facts that are sought.

The testimony of these practitioners of medicine is aided and corroborated by the evidence of many others who had also opportunities of observation—clergymen, overseers of the poor, selectmen of some of the towns, and others whose position enabled them to know some cases of insanity and idiocy.

This Report of the lunacy and idiocy in Massachusetts may then be considered more complete than could be derived from any other sources and through any other channels. It may be, however, that some families have moved into the State or the towns of their present residence with an insane or idiotic member, and have had no occasion to call any physician since their present settlement, and therefore none of our witnesses have had opportunity of learning their facts. Yet these cases are very few, so few as not to vitiate the general accuracy of this Report.

It may then be confidently said that there are, at least, so many insane and idiots in the Commonwealth, and that our State and people have, at least, this amount of burden of insanity and idiocy resting upon them, and that herein is a safe basis of calculation of the amount of public and private responsibility for the restoration or protection of these unfortunate people among us.

Number of Insane

By these means, and with great correspondence, the Commission have ascertained that there were in the autumn of 1854, in the State of Massachusetts, two thousand six hundred and thirty-two lunatics, and ten hundred and eighty-seven idiots—making a total of three thousand seven hundred and nineteen of these persons who need the care and protection of their friends or of the public for their support, restoration or custody.

Of the Lunatics,

1,522 were paupers.

1,110 were supported by their own property or by their friends.

——— 2,632

2,007 were natives.

625 were foreigners.

——— 2,632

435 were curable.

2,018 were incurable.

179 not stated.

——— 2,632

1,284 were at their homes or in town or city poorhouses.

1,141 were in Hospitals.

207 were in receptacles for the insane, in Houses of Correction, Jails and State Almshouses.

——— 2,632

Of the Idiots

670 are supported by friends.

417 are supported by public treasure.

——— 1,087

1,043 are natives.

44 are foreigners.

——— 1,087

Comparison with Other Enumerations

These results differ from those obtained from other surveys made for a similar purpose on the same grounds in Massachusetts, and from the statements made of the number of the insane and idiots, and their ratio to the whole population, obtained from inquiry, estimate, calculation, conjecture, &c., in other countries.

In 1848, a committee of the Legislature, appointed to "consider the whole subject connected with insanity within the Commonwealth," ascertained and reported the number of insane in this State to be fifteen hundred and twelve, of whom two hundred and ninety-one were able to furnish the means of their own support, and eleven hundred and fifty-six were unable to do so, and the pecuniary condition of sixty-five was not ascertained.[1]

In making that survey in 1848, the Commissioners addressed their letters of inquiry "to the municipal authorities of every city and town in the Commonwealth."

These public officers had direct means of knowing the number and condition of the pauper insane, and probably this part of the report was complete; but they had no other facilities of knowing the condition of those lunatics who were in private families, and supported by their own property or by their friends, than other men not in office, and could only speak of those who were within their circle of personal acquaintance. Consequently the report included only a part of the independent insane who were then actually in, or belonged to, the State.

The marshals engaged in taking the national census in 1850, discovered and reported sixteen hundred and eighty lunatics and seven hundred and ninety-one idiots—in all, two thousand four hundred and seventy-one of both classes. It is probable that many of the families refused or neglected to report to these officers the insane and idiots who were within their households.

The census of Great Britain for 1851 gives only the pauper insane and idiots and those who are within the several public and private licensed lunatic asylums, and omits all others; and the ratio of these to the whole population is given.

In 1844, the British Lunatic Commissioners, in a report of great value on the state and progress of lunacy in England and Wales, made an elaborate statement of the number of lunatics within the kingdom; but this included only the paupers and the patients in all kinds of public and private establishments for them, and those others who were not paupers, but under commission—that is, under the guardianship of the Lord Chancellor.

This report did not "include a considerable class of insane persons of all ranks of life under the care of guardians and relations;"[2] and of course all those who were not paupers, and who were at their homes, or boarding with friends or in private families, were omitted.

An enumeration of the people of France was made within a few years. The facts were sought with great apparent care by the agents of the government, and the results published under its authority, aided by the counsel of men of science. Seventy pages of a folio volume are exclusively devoted to the statement of the number and condition of the insane in every department, in each of the seven years [*sic*], from 1836 to 1841 inclusive. This would seem to be a perfectly reliable document; yet a careful analysis suggests some doubt as to its accuracy.

Of the eighty-six departments into which the kingdom is divided, eleven return no lunatics through all of these seven years. Sixty-five return none at their homes or boarding in private families. Some report them in round numbers in even hundreds. Others report the same unvarying number through successive years. One reports two hundred for seven successive years, and another three hundred through six years, without variation. In one, the number increases, in two years, twenty-five hundred per cent., and diminishes as much in four years more. These and many similar statements, equally improbable and unnatural, lead to the inference that they were founded upon estimate, and even conjecture, rather than on personal inquiry and actual enumeration.

In some nations, the statement of the number of the insane includes only those in public hospitals. A writer in the American Medical Journal assumes this ground to determine the number of insane in some parts of Italy, several of the large cities of Europe and Cairo, and calculates the proportion of lunacy to their several people on this basis.

A census of lunacy in Belgium, apparently taken from actual enumeration, is published in the report of the commissioners appointed to inquire into the means of ameliorating the condition of the insane. This report is complete, and perfectly reliable as a matter of fact and as a basis of calculation.

[Eighty-three pages have been removed here, including 24 tables detailing the number of insane and idiots by county, town, nativity, and race. Ed.]

There is, then, one lunatic among every four hundred and twenty-seven, and one idiot among every one thousand and thirty-four, and one of either of these classes among every three hundred and two of the people of Massachusetts.

Regarding the nativity of the people and patients,—among the natives, the lunatics were one in four hundred and forty-six, and the idiots one in eight hundred and eighty-nine, and one of both in two hundred and ninety-five of the Americans. And among the foreigners, the lunatics were one in three hundred and eighty-four and the idiots one in seven thousand nine hundred and thirty-one, and one of both in three hundred and sixty-seven of the strangers. Among the colored population, the lunatics were one in one thousand and twenty-five, the idiots one in nine hundred and twenty-two, and both classes one in four hundred and eighty-five of this race.

This is the measure of the kind of burden of lunacy and idiocy resting upon the State of Massachusetts. We have two thousand six hundred and thirty-two lunatics, and one thousand and eighty-seven idiots, and three thousand seven hundred and nineteen of both. Of the lunatics, two thousand and seven are natives, and six hundred and twenty-five are foreigners; one thousand one hundred and ten are independent, or supported by their own or their friends' income or capital; one thousand five hundred and twenty-two are paupers; and of these, eight hundred and twenty-nine are supported by the cities or towns to which they belong, and six hundred and ninety-three by the State. Four hundred and thirty-five are supposed to be curable, or at least there is not evidence that they cannot be restored; two thousand and eighteen are supposed to be incurable, and these must be supported for life.

In whatever way we look at them, these lunatics are a burden upon the Commonwealth. The curable during their limited period of disease, and the incurable during the remainder of their lives, not only cease to produce, but they must eat the bread they do not earn, and consume the substance they do not create, receiving their sustenance from the treasury of the Commonwealth or of some of its towns, or from the income or capital of some of its members.

There is no escape from this position. Whatever and wherever these lunatics may be, whether native or foreign, independent or pauper, curable or incurable, the Commonwealth is not only deprived of that amount which by their earnings in health they contributed to its income, but more is now needed for their support than when they were able to earn it.

There being, then, no question whether the State and its people will bear this burden and support these lunatics, still the question may be asked, whether the weight may not be diminished in part and sustained in part with more ease to the Commonwealth, and to the towns, and to the friends of the patients.

It has already been stated (page 69 of the Report) that insanity, if not cured in its early stages, becomes more and more difficult to be removed, and, in course of a longer or shorter period, varying mostly from two to five years, becomes fixed and incurable. Then the patient is to be supported for life. On the other hand, if the disease be submitted to proper remedial measures, three-fourths or nine-tenths may be restored, and this proportion of the patients made again self-supporting members of society.

The time required for the cure of different patients, in different forms or degrees of disease, varies from a few months in most cases to a few years in extreme cases.[3]

The question, then, in regard to the curable cases, which constitute three-fourths or nine-tenths of all when attacked, is between the effort and the expenditure needed for their support and the restorative means during the healing process through a few months, or their support during their lives. Between the cost of supporting for a few months and that of supporting for life, no private economist, and certainly no political economist or statesman, should hesitate.

The cost of restoring a lunatic to health, and enjoyment, and power of self-sustenance, and of contributing to the support of his family, and also of bearing his part of the burden of the State, is limited and easily paid in money; the gain is unmeasured. But the cost of lifelong lunacy, distressing and oppressive to the friends who have the patient in charge, is immeasurable, and not to be paid in money.

Humanity would admit of no choice between these; and the State, which is the guardian of the weak and the friendless, should surely not entertain a moment's doubt as to which it should choose.

[The final section includes descriptions of each hospital, prison, jail and almshouse in the State. Recommendations of the Commission include building a new hospital to accommodate the curable and the "furious" patients and revising and reducing the laws "to a code more suitable to the wants and the practice of the times." Ed.]

Source

Massachusetts, Commission on Lunacy. *Report on Insanity and Idiocy in Massachusetts.* House Report No. 144. Boston: William White, Printer to the State, 1855. Reprinted, Cambridge, MA: Harvard University Press by the Commonwealth Fund, 1971.

CHAPTER 14

WILLIAM BUDD
(1811–1880)

The sick are the greatest danger for the healthy; it is not from the strongest that harm comes to the strong, but from the weakest.

—FRIEDRICH NIETZSCHE, *Genealogy of Morals*, 1887

BORN IN NORTH TAWTON, Devon, in 1811, William Budd came from a distinguished family of physicians. His father, Samuel, was a local physician who had served as a naval surgeon during the war with France in 1794. Of Budd's nine siblings, six became physicians. His brother George became a hepatologist, known as the "Budd" in Budd-Chiari Syndrome.

Budd studied medicine under his father, then went to Paris to study for four years under Pierre Charles-Alexandre Louis. Louis's work with typhoid fever, and the observations of French physician Pierre Bretonneau with regard to the same disease, stimulated Budd's interest in how typhoid fever spread within a community. From Paris, Budd returned to the United Kingdom, settling in Edinburgh, where he was awarded an M.D. degree in 1838, as well as a Gold Medal for work on rheumatism. He then served on HMS *Dreadnought* for a few months before himself succumbing to typhoid fever. Returning to the Taw Valley, he established a medical practice. His interest in typhoid fever was well served in choosing this location, as an outbreak soon occurred in the community of 1,300 persons. As he provided care to these individuals, he was able to observe the epidemic firsthand. His observations strongly suggested the presence of a contagion. He wrote his observations in an essay titled "The investigation of the sources of the common continued fevers of Great Britain and Ireland, and the ascertaining of the circumstances which may have a tendency to render them communicable from one person to another," which he submitted unsuccessfully to a medical competition in 1839. Three years later, Budd relocated to Bristol.

In Bristol, Budd became physician to St. Peter's Hospital and to the Bristol Royal Infirmary. Five years later, while attending to a patient in Richmond Terrace, Clifton (a Bristol suburb), he diagnosed typhoid fever. Recalling his earlier conclusion of contagion as the basis for typhoid fever's occurrence, he quickly ascertained a small outbreak of the disease. Among the 34 households, 13 had at least one case of the disease. The only commonality to those households was the use of a well for water; the other 21 families used other sources. Budd concluded that water was the means by which typhoid fever is spread within a population. He also reasoned that Bristol's water supply could serve as a source of such an outbreak, and he pushed for improved water quality while serving on the board of directors for Bristol's water company. John Snow sought to arrest an epidemic by removing the pump handle; Budd sought to keep an epidemic from occurring through his oversight of the local water company.

In 1859, "On Intestinal Fever" appeared in the *Lancet*. In the *Lancet* and elsewhere, Budd's fellow physicians provided additional data supporting Budd's contention that typhoid fever was spread from one infected individual to an uninfected one through contaminated intestinal discharges. Budd argued that his views were those shared by a majority of the medical profession, at least for typhoid fever. Significantly, during the 1849 cholera epidemic, Bristol saw about 2,000 deaths from the disease; in 1866, with Budd's focus on clean water at the Bristol Water Company, the city recorded 29 such deaths.

Typhoid fever was not the only disease with which Budd worked during his residence in Bristol. He also focused on cholera and other diseases, as well. Budd was quick to give credit to John Snow for his work on the etiology of cholera; however, in his tribute to Budd, Robert Moorhead noted that Budd's work on cholera was an influence on Sir John Simon, the first medical officer of health for the city of London. Simon was able to show remarkable declines in mortality from cholera in the city during the same period, associated with changes in the source of the water supply to those less contaminated. However, Simon did not go so far as to accept a contagion as the source of the epidemics seen in England in the middle 1800s until the 1866 outbreak.

Budd's election to the Royal Society in 1871 might have seemed to him the capstone in the illustrious career of a general practitioner. However, there was more to come, as two years later, he published the monograph for which he is best remembered: *Typhoid Fever*. In that same year, however, Budd suffered a stroke. Though he lived another seven years, he did so as an invalid. On January 9, 1880, he died in Clevedon By The Sea.

A Note on the Text

Typhoid Fever was published well after Budd's original observations in North Tawton. Reviewers for the *British Medical Journal* were impressed by the cases of typhoid in North Tawton that Budd presented, but they also noted that the genesis of the epidemics of enteric fever had not been identified. Thus, while the reviewers agreed that tyhoid fever could be a contagion, they were not ready to ascribe it as the only cause.

In *Typhoid Fever*, Budd states that "the sewer has been looked upon as the actual and primary source of the disease, while the infected man has been altogether lost sight of." Such a statement is original in moving the concept of a human reservoir of disease forward, and Budd can be rightly considered a pioneer in this regard. Indeed, his vision of humans as impacted by their environment has earned him recognition in the field of human ecology.

Budd's work was carried out as a primary practitioner, before the bacteriologic revolution. Indeed, the agent of typhoid fever, *Salmonella typhi*, was not discovered until 1880 by Carl Joseph Eberth. Only then did the concept of a symptom-free carrier rather than a water supply emerge as a possibility, a reality that was later confirmed by the case of Mary Mallon, the New York City cook who was responsible for multiple deaths as "Typhoid Mary."

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Typhoid Fever—Its Nature, Mode of Spreading, and Prevention
(1873)

[Based on several publications from 1856 to 1860]

Preface

In 1857, on the occasion of a severe outbreak of Typhoid Fever in the Clergy Orphan School, St. John's Wood, London, I enunciated, briefly, in a Paper published in the 'Lancet,' the doctrines as to the nature and mode of spreading of this fever, of which the following pages only give a fuller development.

For many years prior to the date of that Paper, I had taught these doctrines in my Lectures at the Bristol Medical School, and had acted upon them in practice, in the prevention of the fever, but this was the first time that I had put them before the Profession, in a separate form, in print.

This Paper was followed by a series of others, a part of which appeared in the *Lancet*, and a part in the *British Medical Journal*, down to 1860—papers in which the whole subject of the nature and causation of Typhoid Fever was pretty fully treated.

The substance of these papers, which were founded on observations extending over a period of more than twenty years, is reproduced in the following pages; and, together with some important evidence which has since come into my hands, constitutes the basis of the present work.

While it has been passing through the press, the Registrar General's Report for 1872 has been issued. The Report shows a marked and very encouraging reduction in the mortality from fever, upon the returns of most former years. The deaths from the principal forms of fever—typhus included—were, for the entire year, only 13,507. In the six preceding years, ending with 1871, which, as well as 1872, was a year of comparatively light fever mortality, the yearly average of deaths under the same head exceeded 18,000. In 1866, they were over 21,000: in 1868 they bordered closely on 20,000. At a somewhat earlier date they averaged, for a whole quinquennaid, more than 20,000 per annum.

It will be understood that these returns are for England only, and do not include Scotland and Ireland.

Concurrently with the decrease of deaths from fever in 1872, there was, in spite of the continued prevalence of small-pox, a corresponding decrease in the death rate from most other zymotic diseases, especially in the last quarter of the year, when the rainfall was so heavy.

In that quarter, the seven principal zymotic diseases caused only 16,794 deaths as against 25,907, and 26,977, in the corresponding quarters of 1870 and 1871. 'Abundant rain,' the Registrar General remarks, 'not only mechanically cleanses the streets and sewers, but purifies the atmosphere, and carries off zymotic exhalations which generate disease.'

'Although'—the same distinguished authority continues—'the remarkably low death rate in town districts, last quarter, may be due to the somewhat unusual meteorological conditions which prevailed, [*sic*] it may be safe to assume that a portion of the improvement in their health is permanent, and is the result of the general awakening to the importance of sanitary measures which has been so conspicuous in the last few years.'

There are very special reasons for the hope that, as far as the fever treated of in the following pages is concerned, this assumption will prove to be true.

It is obvious that if the great abatement in its prevalence, observed in 1872, should continue, a considerable reduction will have to be made in some of the numerical statements which occur in subsequent pages, in order to adapt them to current experience.

P.S.—Since the beginning of the present year a series of Reports of local outbreaks of typhoid fever in various parts of the kingdom have appeared, which possess great interest and importance, in their bearing on the leading questions herein after discussed. Among these Reports I may mention two by Dr. Ballard, on typhoid at Nunney, near Frome, and at Hawkesbury Upton, in Gloucestershire, and a third by Dr. Thorne on fever at Whitchurch—all issued by the Medical Department of the Privy Council—as especially valuable in this respect. A Report by Dr. Russell on an epidemic of the same fever at Parkhead, originating in the use of fever-tainted milk, is scarcely less so. These Reports are admirably drawn up, and they all offer the most striking illustrations of the twofold position that typhoid fever is a strictly self-propagating fever, (mainly) disseminated by the specific discharges from the sick. I much regret that they have come to hand too late to enable me to take advantage of the materials they contain.

March, 1873.

CHAPTER I
Introductory

'Time wears off the fictions of opinion, and doth, by degrees, discover and unmask the fallacy of ungrounded persuasion.'

—B. P. Wilkins

Synonyms

English: Gastric Fever—Enteric or Intestinal Fever—Low Fever—Common Continued Fever—Infantile Remittent—Endemic Fever—Pythogenic Fever

German: Darm-Fieber—Darm-Typhus—Ileo-Typhus—Typhus Abdominalis

French: La Fièvre typhoïde—La Dothinenterie—Fièvre entéro-mésentérique

There are few things which concern the people of this country more deeply than to know the exact truth touching the mode in which this fatal fever is disseminated amongst them. Every year, on an average—take the United Kingdom through—some fifteen thousand or more of their number perish prematurely by it: a population equal to that of a considerable city every year swept into the grave by a single, and, as I hope to show, a perfectly preventable plague.

As nine or ten recover for every one who dies, one hundred and forty thousand persons, or more, must every year pass through its protracted miseries. The real amount of suffering involved in this is, however, but feebly represented by these bald figures.

No one can know what they really imply who has not had experience of this fever in his own home. The dreary and painful night-watches—the great length of the period over which the anxiety is extended—the long suspense between hope and fear, and the large number of the cases in which hope is disappointed and the worst fear is at last realised, make up a sum of distress that is scarcely to be found in the history of any other acute disorder. Even in the highest class of society, the introduction of this fever into the household is an event that generally long stands prominently out in the record of family afflictions. But if this be true of the mansions of the rich, who have every means of alleviation which wealth can command, how much more true must it be of the cottages of the poor, who have scant provision even for the necessaries of life, and none for its great emergencies! Here, when Fever once enters, WANT soon follows, and CONTAGION is not slow to add its peculiar bitterness to the trial.

As the disease is, by far, most fatal to persons in middle life, the mother or father, or both, are often the first to succumb, and the young survivors being left without support, their home is broken up and their destitution becomes complete.

How often have I seen in past days, in the single narrow chamber of the day labourer's cottage, the father in the coffin, the mother in the sick bed in muttering delirium, and nothing to relieve the desolation of the children but the devotion of some poor neighbour who in too many cases paid the penalty of her kindness in becoming, herself, the victim of the same disorder!

In its ordinary course, human life has few such consummations of misery as this.

It is impossible to contemplate events such as these, merely as objects of science. It is, indeed, a fundamental axiom in scientific investigation that our emotions should be rigidly excluded from it. But, although, by the nature of things they cannot help in the solution of a problem, they may, at least, be suffered to give a spur to inquiry. Where the interests concerned are the sacred interests of life and death, this is their proper function, and that in a degree of which none of the common alternatives that hang upon human duty can give any adequate measure. It were well with us all if they were more often allowed to have their true weight with the conscience.

Having been by accident thrown much in the way of this fever, I have long felt that it is impossible to bear a part in the calamities of which it is the source, without becoming possessed with a burning desire to devote the best powers of the mind to the discovery of means by which such calamities may be prevented.

From the fact, already referred to, of its being so much more deadly to grown-up persons, this disease has a relation to pauperism which is almost peculiar to itself.

> 'From returns made in 1838 by the medical officers of twenty unions and parishes in the metropolis, it appeared that 13,972 cases of claims to relief on the ground of destitution were created during that year by attacks of fever alone, and that in 1,281 cases the attacks proved fatal. The general deaths from fever in the metropolis during that year appear, from the Summary of the Superintendent Registrar's returns, to have been 5,634.'[1]

It is humiliating to think that issues such as these should be contingent on the powers of an agent so low in the scale of being, that the mildew which springs up on decaying wood must be considered high in comparison.

To know how these powers take effect, in what way they grow to such a height, and to learn therefrom, perchance, by what means their operation may be defeated, are problems in which human happiness is deeply interested.

Perhaps there are few battles to be fought, in which a successful issue depends so closely as here on a real knowledge of the enemy.

If it be true of diseases in general, that all prevention must be based on an intimate knowledge of their causes, how much more true must it be of that great group of diseases which is the work of definite and specific agents, having not only the power of breeding within the body, but capable, for limited periods at least, of existing externally to it? For it is clear, that, in such a case, a thing against which we may be impotent so long as it infects the body itself, may present, on its issue from the body, the conditions of an easy conquest.

That Typhoid Fever is a true member of this group, or in other words, that it is, in its essence, a contagious or self-propagating fever, was proved long ago.

It is scarcely to the credit of the medical profession that this great truth should still be disputed.

Not to speak of the decisive evidence in its behalf recorded by Bretonneau and Gendron de l'Eure, I addressed to the *Lancet* in 1858–59, a series of papers containing observations, which still seem to me to suffice, of themselves, to establish it. The doctrines advanced in those papers as to the origin and mode of spreading of typhoid fever,—doctrines which it is the object of the present work still further to enforce,—are, in fact, entirely founded on this view of its nature.

These doctrines have since received the adhesion of many scientific men of the highest eminence. Among these, it will be sufficient to mention Sir T. Watson, who, in his admirable work on the Practice of Medicine, has not only lent his powerful sanction to them, but has given an exposition of them in that terse and lucid style of which he is so great a master.

But, notwithstanding this, there is abundant reason to believe that, in respect of this species of fever, the great majority, not of the laity only, but of the profession also, still remain anti-contagionists. And this, moreover, is not only true of the rank and file, but distinguished men, who have gained great credit and wide acceptance as teachers of medical science, are to be found, who appear to lean to the same side.

In a Manual on the Practice of Medicine, by the late Dr. Tanner—a book which has reached its sixth edition—the doctrine that typhoid fever is a contagious fever, and is chiefly propagated by the typhoid excreta, is spoken of as 'an illusive hypothesis;' while, in Hooper's 'Physician's Vade Mecum,' another standard work, the Editors, Drs. Guy and Harley, dismiss this doctrine with the following remark:—'Observed facts and the few experiments which have been made tend, however, to disprove these views.'

Treating expressly of the question of contagion, the same writers proceed thus:—

> 'Much doubt prevails whether enteric (typhoid) fever be infectious or not, and the question really turns upon the existence of a distinct, specific poison. Positive proof that it may be conveyed from one person to another is wanting, and certainly the majority of people affected with the disease derive it, upon the clearest evidence, from one

and the same source. Those in attendance upon persons suffering from enteric fever do sometimes fall ill of the disease, but the source of the disease may be present in any house.'

In the discussions on the cause of typhoid fever which filled so large a space in the public papers, both lay and medical, for many weeks together, on a recent memorable occasion, the idea of contagion in connection with the disease was almost universally either ignored or repudiated.

A medical friend of my own, who had the curiosity to read almost everything that fell from the press during that anxious time, tells me that he met with the word 'contagion' but seven times altogether, and that in four of the seven it was only mentioned to be discredited.

The profession in foreign countries, including the leaders of it, seem still to be equally opposed to the idea that the disease is contagious. A foreign Professor with whom I lately discussed the subject—a man second to none in Europe—seemed quite startled to find me contending for its contagious nature, and assured me that his own experience gave no countenance whatever to such a view.

Not long ago, one of the most eminent physicians in the United States held the same language to me.

The practice of both had been confirmed to large cities.

This direct opposition of opinion to fact in a matter of such vital importance, and so open to observation, is as perplexing as it is discouraging. And the more so, because the property of contagion, of which the proof is so clear, so far from being new to disease, is already familiarly known as the common property of a great family group, of which this fever repeats, in unmistakable traits, the family characteristics.

The great natural order of *contagious* fevers has long filled a conspicuous place in nosological systems. In one of the number—small-pox—the contagious faculty has, in past times, even been made use of for the artificial production of the disease on an enormous scale by direct inoculation.

Analogy of the closest kind and of the greatest possible force, is, therefore, at hand to recommend what direct evidence teaches. In other branches of inquiry instances may, no doubt, be cited in which general belief has been slow to follow the advance of knowledge. But such instances, not common at any time, have latterly become more and more rare. Even in the few that have happened, there have commonly been sufficient grounds to palliate, if not to excuse, the popular hesitation and doubt. The problem to be solved has been abstruse; the methods for its solution have been difficult and recondite; the evidence hard to interpret, or the new truth, even when disclosed, has lain beyond the scope of common apprehension. In such a subtle matter as the undulatory theory of light, for instance, it was no great wonder that Young and Fresnel should, for some time, continue to be in advance of their age. But in the case before us, methods are not in question at all—the evidence lies on the very surface of common events, and the conclusion to which it tends, so far from transcending ordinary apprehension, is often so salient as involuntarily to force itself on the mind even of the vulgar, on the first view of the facts.

That this conclusion should still be resisted is, I repeat, very perplexing.

Three principal causes may be cited, as, in part, explaining this great anomaly.

The first is, that medical writers, and especially those among them who exercise the widest influence, pass the greater part of their lives in great metropolitan cities—amid conditions, that is to say, under which, for reasons that will abundantly appear in the following pages, the operation of contagion in this particular fever is not only masked and obscured, but issues in a mode of distribution of the disease, which to the superficial observer would appear to exclude the idea of contagion altogether.

The second:—

The great zeal with which during the whole period of its existence, the General Board of Health, backed by an able and energetic staff and unlimited printing power, continued to urge anticontagionist doctrines.[2]

The third:—

The continued prevalence of very limited views as to what constitutes evidence of contagion or self-propagation in the case of disease.

Formidable as these obstacles are to the reception of more will allow their just weight to facts when well authenticated. The anticontagionist notions of Southwood Smith and his followers in their application to spreading diseases are already rapidly waning, and must soon finally give way before the exact investigations of a more scientific school; while, on the other hand, the extension of scientific culture cannot fail gradually to awaken physicians to wider views on the subject of contagion.

Perhaps it may not be too much to hope that the considerations advanced in the following pages may give some little help in this direction.

It is obvious that the formation of just opinions on the question how diseases spread may depend less on personal ability than on the opportunities for its determination which may fall to the lot of the observer. It is equally obvious that where the question at issue is that of the propagation of disease by human intercourse, rural districts, where the population is thin, and the lines of intercourse are few and always easily traced, offer opportunities for its settlement which are not to be met with in the crowded haunts of large towns.

This is one of the cases, in which medical men practicing in the country have for the acquirement of medical truths of the highest order advantages which are denied to their metropolitan brethren, and which constitute, on the whole, no mean set-off against the greater privileges of other kinds which the latter enjoy.

In the early part of my professional life, while engaged in country practice in Devonshire, outbreaks of typhoid fever continually fell under my eye, amid conditions singularly favourable to the study of its origin and memorable of dissemination.

Of these outbreaks the most memorable occurred in the village of North Tawton, where I then lived.

In addition to the advantages enjoyed by country practitioners, generally, in the observation of such events, there were others peculiar to the position I then occupied.

Having been born and brought up in the village, I was personally acquainted with every inhabitant of it; and being, as a medical practitioner, in almost exclusive possession of the field, nearly every one who fell ill, not only in the village itself, but over a large area around it, came immediately under my care.

For tracing the part of personal intercourse in the propagation of disease, better outlook could not possibly be had.

At the date of the outbreak in question, the people of the place numbered some eleven or twelve hundred souls.

Of these, a small minority, consisting chiefly of women and children, worked in a serge factory. The rest were employed in agricultural pursuits.

The spot on which this community dwelt is richly endowed with all the natural conditions of health. Built on a dry soil, in the midst of an open and well drained country, and occupying the side of a hill sloping gently to the northwest, this village had long been justly noted in that part of Devon for the rare healthiness of its site.

What is more to the present purpose is, that it had for many years enjoyed an almost entire immunity from the fever to which it was so soon to pay so large a tribute.

This is the more to be remarked, because there were in the economy of the place, and in the habits of the people, many things which, according to modern views, are hard to reconcile with such a fact. In the first place, there was no general system of sewers. A few houses, occupied by the more opulent, were provided with covered drains, but all these might be counted on the fingers. In the cottages of the men who earned their bread with their hands, and who formed the great bulk of the inhabitants, there was nothing to separate from the open air the offensive matters which collect around human habitations. Each cottage, or group of three or four cottages, had its common privy, to which a simple excavation in the ground served as cesspool. Besides this, it was a part of the economy of all who worked in the fields, as indeed of many more, to keep a pig, one of whose functions was to furnish manure for the little plot of potatoes which fed man and pig alike. Thus, often, hard by the cottage door there was not only an open privy, but a dungheap also.

Nevertheless, these conditions existed for many years without leading to any of the results which it is the fashion to ascribe to them.

Much there was, as I can myself testify, offensive to the nose, but fever there was none. It could not be said that the atmospheric conditions necessary to fever were wanting, because while this village remained exempt, many neighbouring villages suffered severely from the pest. It could not be said that there were no subjects, for these, as the sequel proved, but too much abounded.

Meanwhile privies, pigstyes and dungheaps continued, year after year, to exhale ill odours, without any specific effect on the public health.

Many generations of swine innocently yielded up their lives, but no fever of this or any other sort could be laid to their charge. I ascertained by an inquiry conducted with the most scrupulous care that for fifteen years there had been no severe outbreak of the disorder, and that for nearly ten there had been but a single case.

For the development of this fever a more specific element was needed than either the swine, the dungheaps, or the privies were, in the common course of things, able to furnish.

In the course of time, as was indeed pretty sure to happen, this element was added, and it was then found that the conditions which had been without power to *generate* fever, had but too great power in promoting its spread when once the germ of fever had been introduced.

On the 11th July 1839, a first case of typhoid fever occurred in a poor and crowded dwelling. Before the beginning of November, in the same year, more than eighty of the inhabitants had suffered from it under my care.

I kept an accurate record of all the principal events which marked this terrible outbreak; and it is to certain of these events, in their bearing on the mode in which this fatal disorder spreads, that I now wish to draw attention.

As, however, the narrative will necessarily occupy some little space, it shall be made the subject of another chapter.

CHAPTER II

Typhoid Fever a Contagious or Self-Propagating Fever

'L'affection typhoïde est-elle contagieuse? La réponse à cette question se trouve dans les faits que la science possède; et il me suffit d'en rappeler quelques-uns pour en convaincre le lecteur.'[3]

—Louis

'J'emploierai le mot *contagion* dans sa signification la plus étendue, désignant sous ce nom toute transmission de la maladie d'un individu malade à un individu sain, quel soit le mode siuvant lequel ele s'opère.'[4]

—PIEDVACHE

The first thing to arrest attention after the disorder had become rife in North Tawton was the strong tendency it showed, when once introduced into a family, to spread through the household. Thus, in the family of Ann N——, a young woman who was taken ill in the second week in July, and who was the subject of the first case, the mother, a brother, and a sister—making four in all—were one after another laid up with the same fever; the father, who had already had the disease in former years, and the young infant, being the only in-mates spared. In another house, four out of six persons were successively attacked; in another three, and so on. Without going into further details of these cases (of all of which I possess accurate notes), it will be sufficient to say that, before the disease finally died away, there were few houses in which, having once appeared, it did not further extend itself to one or more members of the family. This, which was throughout its most striking character, was, in itself, sufficient to lead to a strong presumption of the contagious nature of the disorder.

But while these events were occurring in the village itself, there were others happening at a distance, which converted this presumption into a certainty. During the prevalence of the fever in North Tawton, it so happened that three persons left the place after they had become infected. By a fatality which is but too common under such circumstances, all three communicated the disease to one or more of the persons by whom they were surrounded in the new neighbourhood in which they fell ill. Two of these three persons were sawyers by trade, who had hired themselves for a few weeks to a timber merchant living in the village. While these men remained in North Tawton, they lodged in a court with a single and a common privy, and next door to a house in which the fever was. In the course of time both these men sickened for the disorder, and on the occurrence of the first decided symptoms, both returned to their own homes, in the parish of Morchard, about seven miles off.

The first was a married man, with two children. He left North Tawton on August 9, being already too ill to work. Two days after reaching Morchard he took to his bed, and at the end of five weeks he died. Ten days after his death his two children were laid up with the same fever, and had it severely; the widow escaped. The other sawyer was a single man and an aged couple who lived with him were the only other inmates of the house. Like his comrade, he was driven from North Tawton by indisposition, which rendered him unable to follow his employment, and cut off his means of support. He began to droop on July 26, but did not leave for Morchard until August 2. On the 3rd he finally took to his bed. His attack was severe, but, after a long struggle, he recovered. When this man was at his worst, a friend who came to see him was called upon to assist in raising him in bed. While thus employed, the friend was quite overpowered by the smell from the sick man's body. He felt very unwell from that time, and continued to be harassed for days afterwards by a sense of the same pestilent smell, and by a fixed impression, which under the circumstances was natural enough, that he had caught the fever. On the tenth day from the date of this event, he was seized with a violent shiver, which was immediately followed by an attack of typhoid fever of long duration. Before he became convalescent, two of his children got the same fever, as well as a brother, who lived at some distance, but who had repeatedly visited him during his illness.[5]

The houses occupied by these four men lay some way apart, and, unless underneath their roofs, there was no fever at the time in that part of the country.

Was this series of events, it may now be asked, the result of chance or the work of contagion? If any rational person should entertain doubts as to the true answer to be given to this question, the history of the next case may be safely left to resolve them. The subject who was the means of propagating the disorder in this instance was a widow named Lee, residing in North Tawton. She began to droop on August 20. On the following day, not knowing what was impending, she went to visit her brother, a farmer who occupied a large farm in the hamlet of Chaffcombe, about seven miles off. On the 23rd she was laid up. On the 24th I was sent for to see her, and found her in bed in the first stage of fever. In the after progress of her case, which, though it presented no malignant features, was very prolonged, she exhibited, in turn, all the most characteristic marks of the disorder. Amongst these may be mentioned nose-bleeding, spontaneous and obstinate diarrhoea, tympanitis, dry tongue, low delirium, and other typhoid symptoms, together with (towards the end of the second week) the now well-known eruption of rose-coloured spots. After lying several weeks under my care at Chaffcombe, she slowly recovered.

It may not be amiss to observe, that the fever had become meanwhile so rife at North Tawton, that, while I was attending Mrs. Lee, I had no fewer than seventeen persons under my care in the village in various stages of it.

A few days after she had become convalescent, her sister-in-law (Mrs. Snell), who had nursed her, fell ill of the same fever. Her case was very severe, and, after a protracted struggle, terminated fatally on November 4. The husband (Mr. Snell), who had spent the chief part of his time in his wife's sick room, and had sat up many nights by her, in great anxiety and distress, was the next sufferer. He begin to droop in the last week of October, but was not finally laid up until the day of his wife's death. After having lain for some time in a very precarious state, he recovered. While he was yet ill—at the end of three weeks, in fact, from the date of the seizure—one of the farm apprentices was attacked in the same way. Then followed a lad employed as day labourer on the farm; and then Miss S———, who had come to take charge of the house after the death of Mrs. Snell. Next in order came another apprentice; and again, as a last group, a servant man, a servant girl, and another young person (a daughter of Mrs. Lee), who, until she was laid up, had acted the part of nurse.

As far as external conditions went, the sanitary state of the homestead which had become the seat of this terrible scourge differed in nothing from what it had been for many years before, during which the household had continued to enjoy perfect health. The only new incident in its history was the arrival of Mrs. Lee from the infected village, seven miles off, with the fever upon her. What, perhaps, is still more to the point is, that many other such homesteads lay near to this one, which were far worse off in respect of these same conditions, but in which no fever of this or any other kind existed. There was no single case of the sort, indeed, within miles of the place, or nearer than North Tawton, whence the taint had been imported.

The outbreak, severe as it already was, did not, however end here. In order to lighten the burden of so heavy a sick list, the servant girl, already referred to as one of the sufferers, was sent to her own home (a small cottage in the hamlet of Loosebeare, about four miles away) as soon as the first symptoms of illness appeared. Here she lay ill for several weeks under my care. Before she had recovered, her father, a farm labourer of the name of Gibbings, was likewise seized, and narrowly escaped with life. A farmer, named Kelland, who lived across the road, and who visited this man several times during his illness, was the next to take the disorder. His case was, in turn, followed by others under the same roof; and the fever, spreading from this to other houses, became the focus of a little epidemic, which gradually extended to the whole hamlet.

Scattered over the country side there were some twenty or thirty other hamlets, with the condition of which I had long been intimately acquainted, and which in all things were the precise counterparts of this. Two or three farmyards and a few labourers' cottages clustered round them, made up, in each case, the little community. In each of these were the usual manure-yard and the inevitable pigsty; in each there was the same primitive accommodation for human needs. The same sun shone upon all alike, through month after month of the same fine, dry, autumnal weather. From the soil of all, human and other exuviae exhaled into the air the same putrescent compounds, in about equal abundance. In some amongst them, indeed, to speak the exact truth, these compounds, if the nose might be trusted—and in this matter there is no better witness were much more rife. And yet, while at Loosebeare a large proportion of the inhabitants were lying prostrate with fever, in not one of the twenty or thirty exactly similar places was there a single case.

To explain a contrast so signal there was but one fact to appeal to—the arrival from Chaffcombe, where the fever was already raging, of Mary Gibbings with the disease actually upon her. Before that event, in spite of manure heaps, pigstyes, and the like, Loosebeare, too, was free from the malady. The diseased intestine of the infected girl had continued to deposit its morbid excreta upon the soil for a fortnight or more before the fever began to spread, and the first cases that succeeded to hers sprang up immediately around her person.

The Chaffcombe tragedy—if I may so call it—had yet another episode. One of the boys already mentioned in the infected list, was the means of widely disseminating the fever in quite another direction. This boy, who was employed as day labourer on the farm, lived, when at home, in one of a pair of cottages standing by the roadside, about midway between Bow and North Tawton. The cottage in question was occupied by the boy's mother; the cottage next door by the husband and family of one of her married daughters. Of the ten persons who, one after another, contracted fever at Chaffcombe, this boy, Oliver Lang, was the fifth in order of attack. Like Gibbings, he was sent home to his friends as soon as he fell ill; and he took to his bed in the last week of December. I attended him for a long time at his mother's house, and his case was very severe. Before he had become fully convalescent, his mother, who had nursed him, sickened; and while she yet lay ill, his sister took the fever. In the last-named subject the course of the disease was unusually rapid, terminating fatally as early as the ninth day. On January 24 she had a severe shiver, on the 26th she was unable to leave her bed and on February 2 she died.

The next to be attacked were two children of the family next door, every member of which ended by being laid up with the disorder. Another married daughter (a sister of Oliver Lang), who had come from a distance to take care of her sick relatives, being at length infected, became, on her return home, the means of propagating the fever in yet another quarter. This new group of sufferers also fell under my charge; but, as the history of the introduction and spread of the fever amongst them would only offer a repetition of incidents precisely similar to those that have gone before, I need not further pursue it. It is only important to add that, with one exception, all the cases included in the last narrative were either under my own care, or under that of one of my brothers, who was associated with me in their treatment, and that I kept, as I have already stated, an accurate record of them at the time of their occurrence, with the express view of illustrating the mode of propagation of this particular species of fever.

In the next case the disease did not spread so widely among the attendants on the sick as in the examples already given, but it brought some other relations into view, which render it worthy of being placed on record.

In the summer of 1855, Miss R——, a lady residing on St. Michael's Hill, Bristol, went to spend a few weeks in France, taking a party of five young ladies with her. After passing a month at Havre, one of the number was obliged to return home; the other five went to Paris. On their arrival there, they took an apartment in a '*hôtel garni,*' near the Bourse, which they continued to occupy during the nine days of their stay in the French capital. Being limited as to time, and this being their first visit, they gave themselves up to sight-seeing with the ardour usual under such circumstances, and incurred great fatigue in consequence. Some days before quitting Paris, they discovered, from the frequent passing to and fro of Sisters of Mercy, and from other unmistakable signs, that some one was lying dangerously ill in their hotel, in the apartment next to that which they occupied. On the day preceding that of their departure for England, a priest made his appearance on their landing, and, on inquiry, they were told that he had come to administer the last sacrament to a lady who was dying of '*la fièvre*.'

On Thursday, July 20, they left Paris, and reached Sydenham in the course of the same day. The day following they devoted to the Crystal Palace, and, in the evening, they parted company. One of the young ladies went to Pembroke, and another to Tetbury; while Miss R——, with the other two, came to Bristol. On the day following, one of the two, who had already shown symptoms of illness at Sydenham, was laid up. She kept her bed some weeks, and her disease was pronounced to be 'gastric fever.'

In the middle of the next week, the other three young ladies, who had continued well up to that time, began to droop; and on Saturday, July 29 exactly nine days after leaving Paris—they were all in bed with the same fever. The young lady from Tetbury died after a month's illness; the other three recovered. Of these three, one, a Miss T—— was attended by myself throughout. Her case, which was a very severe one, presented in turn all the most characteristic marks of intestinal fever. Towards the latter end of the second week, there was a copious eruption of the well-known spots; and, in the course of the third, she very nearly died of intestinal hemorrhage. On September 14, Mary Y——, a servant who had nursed her, began to droop; and on September 19, was admitted into the Bristol Royal Infirmary, suffering from the same fever. The case proved to be a mild one, but presented all the diagnostic marks of the disease, including the characteristic eruption of rose-coloured spots. There was at that time no other case of fever on St. Michael's Hill. Miss R——, who was an elderly person, and the young lady who did not accompany the party to Paris, escaped illness.

From this narrative it is clear that the four young persons who, in different parts of the kingdom, were thus attacked, within a few days of one another, by this specific fever, derived it from a common source. That this source was the sick lady who was their fellow-lodger in Paris, although not so certain, was in the highest degree probable. That Mary Y—— caught her fever from Miss T——, by attending on her, there could be no reasonable doubt.

In the next case the events offer, with some slight variations, a repetition of those which occurred at Chaffcombe.

The scene of the outbreak, in this instance, was a farmhouse, situated on the crest of a hill five miles west of Cardiff, and overlooking the village of Penhavod. Prior to this outbreak, fever had not occurred at the farm within the memory of man. The house itself was ill built, and the ventilation especially very defective. It was provided with a common privy, placed in one corner of the garden, about twenty yards from the house. That the place was not unhealthy, however, was proved by the fact that the owner of it had brought up there a family of seven children, who, up to the date of this visitation, were the very type of luxuriant health. Several members of two preceding generations had attained to great longevity on the same spot. In respect to sanitary conditions, the homestead was in precisely the same state in which it had been for many years past.

Such being the position of things, on December 16, 1858, an event occurred which proved to be of the most tragic moment to all concerned in it. On that day, one of the sons, William Phillips, a lad about twelve years old, was brought home from a boarding school at Cardiff in the first stage of typhoid fever. He was sent away from the school in consequence of having the fever upon him.

In this, as in all the cases which followed, the intestinal discharges were thrown, sometimes into the common privy, and sometimes into a large open pit, surrounded by a low wall, which served as an ash-pit. This pit was situated within a few yards of the back door of the house. The tainted linen was washed in the washhouse near the back kitchen, a place which all the household frequented. Before the arrival of the infected lad, the family, as I have already said, were in the enjoyment of good health, and the neighbouring village and farms were entirely free from fever.

In the third week of his illness, Emma Phillips, one of the sisters, five years and a half old, was attacked with the same fever as that under which her brother was labouring, and died of it towards the end of the second week. A few days after Emma, Maria, another sister, aged eighteen years and a half, was seized with the same malady, which proved fatal on February 1, 1859.

While these two lay ill, a man-servant and a maid-servant also became infected. Both were sent to their own homes as soon as the first decided symptoms appeared, and both died of the fever after short illnesses. Within a day or two, Elizabeth, another sister, seventeen years old, was seized, and at the date of my visit had not yet perfectly recovered.

On January 31, John, a brother, seven years old, was laid up, and remained for several weeks in a very precarious state. A hired nurse, who had attended several members of the family in succession, afterwards took the infection, and had the fever severely.

On February 8, I saw William, Elizabeth, and John—, the three surviving sufferers, in consultation with Mr. Rees, of Cardiff. The condition of all three was characteristic of the respective stages of the disease under which they were labouring. Elizabeth had had intestinal hemorrhage three days before I saw her, but appeared to be doing well. In John, who had been nine days in bed, all the diagnostic marks of fever were in full development. In addition to the typhoid symptoms, commonly so called—including prostration, wandering, deafness, subsultus tendinum, and dry, encrusted mouth—there was diarrhoea, tympanitic belly, and one of the best marked eruptions of rose-coloured spots I have ever seen. William, who first brought the fever home, was still in that state of abject weakness and extreme emaciation which is one of the most characteristic results of this fever when severe and protracted; his shaven hair had only just begun to grow, and he bore on the nape of his neck a large, deep ulcer, which had formed there, in the course of the fever, by the sloughing of a blistered surface.[6]

Three additional illustrations, borrowed from other observers, will suffice for the present.

The first is taken from the admirable series of Papers by Gendron de l'Eure, on the 'Epidemics of small Localities,' published in the 'Journal des Connaissances médicales.'

On the 8th May 1828, a girl, named Lemonnier, was brought to the hamlet of Drouanderie. She came from Caumont, a town a league off, and on her arrival was already in the 12th day of typhoid fever, contracted in her master's house (fever, I may add, being already epidemic at Caumont).

The inhabitants of these two places had held hither to no communication. They are separated by two communes, in which there were no fever cases.

The mother of this girl, a woman 60 years old, after nursing her daughter for some weeks, was attacked by the same fever. She was nursed in her turn by two neighbours, Guilliet and Bardet by name, who relieved one another, until the arrival of another of Lemonnier's daughters.

Guilliet was next laid up with typhoid, and kept her bed forty days.

The following persons living under the same roof next suffered:—

Madeline Guilliet, 25 years old; Guilliet, the father, 53 years old, who died in the fourth week; Guilliet, the son, aged 17 years.

Two servant girls, who, in fear and trembling, rarely visited the sick, but were, nevertheless, attacked.

The woman Bardet, who divided with Guilliet the care of Lemonnier, also took the fever, and was four weeks in bed.

The following inmates of her house were afterwards attacked:—

Julian Bardet, her son, eleven years old.

Constance Bardet, sixteen and a half years old: death in the fourth week.

Louis Bardet, aged eight years.

Francoise Bardet, not resident with her mother, but who visited her, also got fever.

The entire population of this hamlet numbered nineteen persons, of whom *one only, an infant at the breast,* escaped. It is probable from this and other circumstances that in this outbreak the fever was propagated through the drinking water.

The next case is by the illustrious Bretonneau, who was the teacher of M. Gendron, and one of the first to establish the contagious nature of the malady.

In one of his papers on typhoid fever he says:—

'Dr. Potier has recently witnessed a case in which typhoid fever attacked all the young ladies of a school in the Faubourg St. Germain, without even one escaping. The first affected was a young lady recently come from the country.'

Now, at that time there was no typhoid fever anywhere in the neighbourhood of the school. With the history of the Chaffcombe and other outbreaks before us, we may well ask, with M. Bretonneau, 'to what can such a striking difference be due, save to the contagious nature of the malady?'

The third and last case is taken from an account, in one of the Reports of our own Privy Council, of a severe outbreak of typhoid which occurred in the village of Kingston-Deverill, in Wilts, a few years since.

'September 1st the *first* patient came under medical treatment; a man of the poorest class, an habitual tramp who for some time before his attack had been absent from home, and must, (it seemed), have contracted the disease while on his travels; the *second* case was in the person of this man's mother, who had come from her home on the other side of the village to stay with and nurse him during his

> illness, and herself required medical treatment on September 23rd. The *next* patients were two women (one of them living next door, west, to the first-infected cottage; the other living in another group of cottages), who, both of them, had frequented the first-infected cottage and had given help in nursing there; the *fifth* attacked (October 9th) was a child of other next-door neighbours (east) of the first patient. The disease eventually spread to more than twenty cottages, scattered, singly, or in little groups, about the large area of the village. In some cases, several inmates of the cottage were attacked—father and mother, and even three, four, or five children, and the infection of the disease was in at least one instance conveyed to a neighbouring village.'

(Third Report of the Medical Officer of the Privy Council, pp. 8, 9, 10.)

At the date of this Report, out of a total population of about 400 persons, 66 had already been attacked, and six deaths had occurred.

Truly, a touching, as well as most instructive history. And all this, not through foul smells, or the action of mere 'pythogenic' compounds which, no doubt, were as rife before the fever as during its course, but simply through direct importation of the fever itself, by a poor tramp.

✤✤✤✤✤

I shall not weaken, by any lengthened commentary, the force of the facts just related.

Observed under conditions singularly favourable for tracing the order of events,—recorded by men whose good faith is beyond suspicion, and, in the most decisive of the instances, open to no ambiguity from any quarter—they fulfill every condition that can be required of evidence in such a case, and, in spite of all that has been asserted, and is still maintained to the contrary, furnish sufficient proof that this fever is an essentially contagious or self-propagating fever.

If need were, it would be easy to show, by the doctrine of probabilities, that to attempt to explain them on any other principle, would be absurd.

But it would be a waste of time and power to demonstrate by elaborate methods what common sense apprehends at once. The facts tell their own tale, and tell it in language so plain, that it cannot be misinterpreted.

Nor must it be supposed that the facts themselves are in any sense exceptional. Instances of such wholesale infection as some of those adduced are, no doubt, only to be met with under particular circumstances of season, place, and habits of life. Instances equally decisive as to the propagation of the disease by personal intercourse abound. So true is this, that I could easily multiply to a large extent, from my own experience, cases in which this fever was imported into previously healthy districts, and there disseminated by persons who had contracted it in distant places. Indeed, I can safely affirm, that while I continued in country practice, it scarcely ever happened for three months to pass away without cases of this fever coming before me, under conditions that contained strong evidence of communication by contagion.

Now I need scarcely add, that of the various properties that can be shown to belong to any given malady, this one, of all others, is incomparably the most important. In the first place, it is clear that, in a far higher sense than can possibly attach to any other conceivable property, this mode of propagation sets upon a disease the stamp of a specific nature. In order to appreciate its full significance in this respect, we must not forget that, like the other contagious fevers, this fever, in particular, not only propagates itself, but, if common observation can be trusted in such a matter, propagates no other kind. In the numerous cases in which I have seen the disease palpably spreading by contagion, the offspring has always borne the same specific marks which distinguished the parent; and one case has followed another with the same constancy of specific type with which small-pox follows small-pox, or measles succeed to measles. It is well known, in fact, that there are many countries in which continued fever is not only common, but rife and in which this particular kind is the only kind that occurs. But *to propagate itself and no other,* and that in a series of indefinite progression, constitutes the very essence of the relation on which the idea of species is founded. How much this implies in the animal and in the plant we all know. It is strange that what it implies in the case of disease should be so seldom recognised.

'That,' saith Hooker, *'which doth assign to each thing the kind;* that which determineth the force and power; that which doth appoint the form and measure of working, the same, we term, a LAW?' If these be the true titles to the designation of law, the law of self-propagation, as exemplified in the great group of fevers, not only possesses them all, but possesses them in an intense degree. This becomes more and more clear the more deeply we seek to penetrate into what is involved in the fact.

In the case before us there can be no ambiguity as to what the fact really implies.

The existence here, *as in the other contagious fevers,* of a latent period after the occurrence of infection; the exemption conferred by one attack against any future attack; and, lastly, the immunity of large numbers of persons, who, though freely exposed to the fever poison, yet remain proof against it,—are characteristics of which the significance cannot be doubtful. All three are characteristics of a very special order, and spring from a common root. Of the last-named of the three, as of a thing patent to all, nothing more need now be said. In offering some observations on the first and second, I am aware that I am laying myself open to the charge of illustrating what is already familiar, and of undertaking to prove what is already admitted. But if I transgress in doing so, I will, at any rate, endeavour to be brief.

Of the occurrence of a latent period, several well-marked illustrations have already been incidentally recorded in the last chapter. To these I shall content myself with adding the three following:—

(a) In the autumn of 1854, typhoid fever broke out in a school for young ladies at Taunton, and spread so much that it became necessary for the time to 'break up.' Amongst those who were sent to their homes was a young lady named Oliver, whose family lived at a farm in the country, a few miles from Bridgwater, in an isolated spot. For more than a week after her return home, this young lady appeared to be in her usual health. On the tenth day after her arrival she was seized suddenly with fever, which laid her up for several weeks, and very nearly proved fatal to her. There was no other case of fever at the time in the neighbourhood of her home, and she was the only inmate of it who suffered.

(b) In the month of March 1853, I was called to attend a family in Park Street, Bristol, in which two children had been affected one after another with typhoid fever. At my suggestion, a third, a little girl eight years old, who had hitherto escaped, was sent into the country to a neighbourhood where no fever was. Here she remained for three weeks in entire separation from her friends, and with little or nothing amiss. At the end of the third week she began to droop, and in the middle of the fourth she was brought home with all the characteristics of typhoid fever upon her.

(c) The third and last example is taken from the outbreak of fever which occurred at the military school of La Fleche, in 1826. In this example, the peculiarity of the circumstances gave a scientific clearness and precision to the facts but rarely met with in medical evidence. The fever first broke out in the school in the month of July, and did not cease until 109 students had been attacked by it. Amongst those who suffered were 26 who had been sent to their own homes in distant parts of France, in the vain hope that they might-thus escape the disease which was spreading among their comrades. These 26 young men were, to all appearance, perfectly well when they were sent away, and continued to be so for more than a week afterwards. In the second week they began to droop, and before the week had ended they were all laid up with typhoid fever. As it may be considered certain that these 26 subjects contracted the fever at the school, it is plain that the poison must have remained latent in their bodies at least a week or ten days.

Of the existence in this, as in all the other contagious fevers, of the remarkable immunity which one attack confers against any future attack of the same malady, the evidence, although requiring more pains to collect, is not less conclusive. M. Bretonneau, who, I believe, was the first to draw attention to this remarkable and all-important characteristic, avers that for a period of thirty years he had never seen an instance of this fever occurring twice to the same person.[7] In regard to the same point, Chomel[8] expresses himself in the following terms, which, precise and decided as they are, acquire additional weight from the well-known scrupulous accuracy of the writer:—

> 'We have already said that typhoid fever, in ordinary circumstances, only affects the same individual once. This appears from all the facts hitherto recorded. From the time when physicians began to make special and consecutive researches on this malady, no authentic instance to the contrary has been observed, although the number of cases of typhoid fever annually studied is so considerable that examples of recurrence must have been met with, had the disease been susceptible of occurring more than once in the same subject. Although in interrogating our patients we have always taken care to call their attention to this point, they have never answered in a manner to lead us to believe that they had already had the disorder; and, after all, even were some opposite facts now and then found in a disease of such great frequency, a few exceptions would have nothing extraordinary in them, and would not destroy the kind of *law* which has just been enunciated; for small-pox, scarlet fever, and measles, which ordinarily attack the same individual once only, recur sometimes, especially in great epidemics of these disorders. It would not, therefore, be astonishing if examples of the same kind were now and then met with in the case of typhoid fever.'

Louis, who on all points relating to the natural history of this fever is the greatest of authorities, living or dead—whose monograph on it is unique in medicine as a model of elaborate research—and whose conscientious accuracy is only paralleled by his slowness of belief, declares himself to the same effect in language which is the more striking from the contrast it presents to the caution with which he expresses himself on most other subjects.[9]

Among many illustrations of the fact which he cites from Gendron de l'Eure, especially remarkable is the case of the town of Caumont, which was swept twice by an epidemic of this fever, with an interval of eight years between, and in which all the persons who were attacked with the fever in the first visitation were spared in the second.[10]

I may add, that my own experience is in entire accordance with that of these distinguished writers. For seven years, I made careful inquiries as to the point in question in every case of this fever that fell under my charge; and during the whole of that period, although my range of observation included two great epidemics, in addition to a large average of fever patients, I only met with three subjects in whom there was reason to believe that the disease had ever occurred before. To these three I added a fourth in my own person shortly after.

During the same period, I was constantly meeting with persons who, having once had the fever, remained perfectly well under prolonged and intense exposure to its specific poison, while all around them were falling victims to it. Of such persons, I have many still vividly in my mind, who, by the very accident of having acquired in this way an exemption which none around them possessed, continued to perform for weeks, and sometimes for months together, the exhausting and dangerous office of nurse to the other members of an infected household, and who, nevertheless came out harmless.

In reference to the four who were not so fortunate, it is only necessary to remark, that in no one of the contagious fevers is the protecting power of a first attack absolute. In the space of the same seven years, indeed, in which these cases came before me, I met with five others in which *small-pox* happened twice to the same person. And yet that, as a rule, small-pox occurs only once in life, is a fact established on a larger basis than any other fact in medicine. The occurrence of exceptions in the case of small-pox is, therefore, *the best possible proof* that the occurrence of similar exceptions in the case of typhoid fever does not invalidate the remarkable law in which both participate.

I shall have to recur to all these points in another place. I have already said that their real significance cannot be doubtful. They define at once, indeed, the position and natural affinities, as well as the true pathology, of the disease to which they belong. For had we no other light than that which is afforded by them, we should see clearly enough that in the specific cause of this fever we have to deal with one of that remarkable group of poisons which, in order to produce their specific effects, require in the human body not only a subject for their action, but conditions for their growth and development. This is a conclusion of immeasurable importance to the inquiry in which we are engaged. That the operation of all the poisons belonging to this group is entirely dependent on their own reproduction in the living body, may, I repeat, be inferred with great certainty from the relations on which we have just been dwelling. But the fact stands on even still surer ground. Demonstrable in all as a matter of inference, it has actually been demonstrated in one of the number as the result of experiment.

Of the diseases which the three very striking characteristics I have been endeavouring to illustrate separate into one great natural order, small-pox may be taken as the type. In very essence a contagious fever, it is a fever in which a period of incubation, on the one hand, and the protection conferred by an attack of the disease, on the other, have become experimental facts. For, with the introduction of inoculation, small-pox became the subject of an experiment (not the less instructive because instituted for a purely practical object) the most gigantic of any that has yet been applied to the phenomena of life. Adopted as a purely sanitary measure, and finally superseded, as such, by Jenner's admirable discovery, it has not the less left to us a legacy of the deepest scientific interest. On all the relations we are here considering it has thrown the clearest light.

Possibly we may never be able to understand *all* that is involved in what is called the 'latent period;' but it is, at the same time, as clear as day that its root lies in the infinitesimal minuteness of the dose, which inoculation *experimentally* shows to be sufficient to the specific effect of the morbid poison. In the same way, the intimate nature of the material conditions which protect, for the remainder of life, the body that has once gone through one of these diseases against any future attack from it, may, possibly, always transcend our means of research. But the practice of inoculation in the production of small-pox has shown, with a clearness and precision which are seldom exceeded, even in physical science, and with a certainty which cannot be surpassed, that these conditions, whatever their ultimate essence may be, *are, in fact, the conditions which attach to the reproduction of a specific poison in the most intimate recesses of the human body, by that most specific of processes which constitutes a contagious fever.* The disease named small-pox only occurs once in life, simply because the small-pox poison *cannot grow again* in a body in which it has once bred. In such a body, as experiment has often shown us, even the reinoculation of the virus remains sterile and without effect.

On the other hand, it lies in the very nature of things that characteristics so cardinal as these—characteristics which are, at once, common to this group of diseases, and peculiar to it which are perfect in their analogy one with another, but have no perfect analogy with anything we know of in nature besides—must have a common ground. The latent period in typhoid fever must be the same thing as the latent period in small-pox; the still more remarkable phenomenon of the protection conferred by one attack against any future attack must be in essence the same in the two diseases. So that if typhoid fever happens only once in life, it is, as in small-pox, simply because the fever poison *cannot grow again* in a body in which it has once bred.

Here, if anywhere in our knowledge of disease, we are on sure ground. To appreciate the whole strength of the case, we must keep *this* constantly before us, that the leading fact of it, the great fact of all, has, in one instance, not only been experimentally revealed to us, but revealed by an experiment which for clearness of result is almost without parallel. In inoculated small-pox how striking is the way in which the great fact of the growth and multiplication of the specific poison in the living body is brought to light before us! The virus that is inserted in a speck so impalpable that the mind almost fails to figure its minuteness—so inappreciable that even the inoculated body takes at first, if I may so speak, no overt cognisance of its presence—issues before long in a new stock, which may not only poison the same body unto death, but is sufficient to impart the seeds of death to myriads of others. In most other provinces of medical inquiry we have cautiously to grope our way in the dark; but here some of the highest mysteries of disease are laid open to us in the form of visual phenomena that cannot possibly be misinterpreted. Germ and offspring, seed and crop, lie both before us, and the result, if not the nature, of the intervening process is as plain to the eye of the physician as that which the cornfield exhibits to the husbandman in the teeming increase of the scanty grain which his own hand had scattered.

What we actually *see* in small-pox—in the typical member of the group is but a picture of what occurs in the rest. In typhoid fever, as in small-pox, it is the act of growth (with all that is incident to it) that kills; that constitutes the disease, in fact; and where the conditions for this growth are wanting, the poison is powerless. Whether in this fever the scale of reproduction be as vast as in small-pox, we have not the same ocular means of judging; but that it is the same in kind, and immense in degree, the whole history and evolution of the disorder prove. *The living human body, therefore, is the soil in which this specific poison breeds and multiplies; and that most specific of processes which constitutes the fever itself is the process by which the multiplication is effected.*

This is what contagion in typhoid fever really implies, and it is thus that provision is made for the perpetuation of the malady.

To many, these reflections will no doubt appear superfluous. I have thought it well, however, to introduce them here, because, even amongst those who admit the contagious nature of this fever, there is often a lurking disposition to ignore or evade the consequences which flow from the fact. Thus, by some, this quality, if mentioned at all, is passed lightly over as an incident of no importance; as a circumstance that may perhaps deserve a passing notice, or justify some precautions, but as in nowise touching the essence of the disease. Others, with an inconsistency that seems still more flagrant, assert that this fever is by nature non-contagious, but that it may become contagious under certain circumstances! If nothing more were meant by this than that its propagation by contagion requires conditions, there could be no objection to such a statement. But it is clear, from the terms used, that this is not what is meant. It is equally clear that if the views of what this mode or propagation implies here taken be true, the use of such language betrays an entire want of conception of the real import of the fact. To suppose that this fever is sometimes contagious and at other times not, by reason of some intrinsic difference in the case itself, is just about as rational as to suppose that small-pox could continue to be small-pox and cease to reproduce and throw off the small-pox virus.

As in small-pox so in typhoid, to spread by this mode of reproduction is not only a characteristic, but the *master*-fact in its history.

The question of contagion settled, the next that arises is, in what form and from what surface or surfaces is the specific poison cast off by which the disease is propagated?

Now, I have no difficulty in at once giving my opinion that *all* the emanations from the sick are in a certain degree infectious. At the same time, it is one of the principal objects of this work to show that what is cast off from the intestine is incomparably more virulent than anything else. The full consideration of the grounds on which this last conclusion is founded is reserved for the succeeding chapters. It may not, however, be amiss to observe, thus early, that striking evidence of its truth may be found in facts that are familiar to all.

I have said that events such as those just related are common. It should be added that, common as they are, they never occur except under one condition—that is to say, where no sufficient provisions have been made for preventing the discharges from the human intestine from contaminating the soil and air of the inhabited area. Where these provisions are wanting, the most spacious rooms, and the freest internal ventilation, afford no certain security against the spread of the fever. I could give the most striking instances of this, if need were. It was the almost entire absence of such provisions at North Tawton and at Chaffcombe, which gave to this scourge, when once it found its way there, such deadly power. Where this one condition exists such events are of common occurrence; where it fails, they never occur at all. So true is this, that I doubt not that those whose practice has only lain amongst such inhabitants of large towns as live in houses provided with good drains, and especially with good water closets, will find it difficult to believe that the disorder which the foregoing narratives show to be possessed of such virulent powers of propagation by contagion, can really be identical with the fever which, in their own sphere of observation, has seldom appeared in more than single cases, or given other than doubtful evidence of being possessed of such powers at all. On the other hand, neither do I doubt that those who, like myself, have been much conversant with the malady as it appears in country places, will see in these narratives but the reflection of their own experience. In both cases, the nature of the disorder is one, and its power to propagate by contagion the same. But in the one case, the alvine discharges are no sooner passed from the diseased intestine than they are swept far away from the house where the sufferer lies; while in the other, these discharges continue to accumulate, day by day, upon the soil on which the dwelling stands, and to exhale their poison into the air breathed by the inmates, or to distil [*sic*] it slowly into the water they drink. The extreme contrast in the result, in circumstances that differ only in this one condition, is of itself all but decisive of the question.

The power of the sanitary arrangements just referred to, in almost infallibly preventing the spread of a fever, which, in their absence, often strikes down several members of a family in succession, in spite of the presence of every other favourable sanitary condition, seems to show, with a force of evidence that is irresistible, that while this fever is an essentially contagious fever, the contagious element by which it is mainly propagated is contained in the specific discharges from the diseased intestine.

Like malignant cholera, dysentery, yellow fever, and others that might be named, this is one of the great group of diseases *which infect the ground*. Hence the quasi-miasmatic character attaching to them all, which has misled so many observers as to their true mode of spreading. In another chapter I shall offer still more specific proofs of the truth of this statement. Meanwhile, it may still further advance the argument, to inquire what is the real significance of that peculiar disease of the intestine which throws off the noxious matter.

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The doctrine that typhoid fever is contagious has to contend against another class of objectors, whose reasoning it may be well shortly to consider before we proceed further. To set aside this doctrine, one of two things is clearly necessary: either to show that the facts on which it rests are not true, or that, being true, they may bear another interpretation. But many persons of credit are to be found, both in this country and abroad, who, although confessedly unprepared either to deny the evidence or to dispute the logic, yet repudiate the doctrine, simply because it does not seem to tally with their own experience. These reasoners appear to think it a sufficient answer to the whole case to allege that, in their observation, this fever has seldom spread to the attendants on the sick, and that the cases in which this has happened have been the exception and not the rule. The answer to these persons is, that in the decision of this question, the observations on which they rely are really of no weight. One would have thought it would have been obvious that when once a disease has been proved by positive evidence to be contagious, no amount of negative evidence can prove the same disease not to be so. The same thing cannot be by its nature at once barren and prolific. On the most superficial view, it is clear that the utmost which is implied by the fact on which these non-contagionists rely is, not that intestinal fever is not communicable, but that its communication requires some special conditions. But this may be said of the whole class of contagious diseases.

As might have been expected, the objection in question proceeds almost exclusively from those whose practice lies amongst the rich inhabitants of large towns, in whose families, for reasons already given, this fever very seldom spreads. But the fact itself is not even good for what it is supposed to be worth. Because the fever does not extend to the immediate attendants on the sick is no proof whatever that it does not extend itself elsewhere.

It is scarcely necessary to observe, that the specific agents by which contagious fevers are propagated are cast off in a material form by the infected body of the fever patient. Some are eliminated from one surface, and some from another. But, in regard to this point, there is a rule which, so far as I know, has no exception. It is that the most characteristic of the *ejecta or excreta* in each disease are, in the same disease, the principal vehicle of the morbid poison. This truth is so familiar that it needs no particular illustration.

Now, it will be shown in the next chapter that of all the morbid products thrown off by the (intestinal) fever patient, the discharges from the diseased intestine are, in every sense, the most characteristic. These discharges contain matters on which the fever poison has set its seal in the most consummate fashion. Wherever they travel—wherever exhalations from them penetrate—there, at least, the most specific of all the exuviae from the sick body are in operation. The sewer which is their common receptacle, is, so to speak, the direct continuation of the diseased intestine.

To prove that any particular case of this fever has remained without progeny, it is, above all, necessary, therefore, to prove that the intestinal discharges from it have not, after their entrance into the sewer, been the cause of fever in any second person. To teach, in the absence of such proof, that the disease is not contagious, because the immediate attendants on the sick escape it, is simply to show that those who use such language have not realized the most fundamental conditions of the question they undertake to decide. It is much the same as to argue that, because the next successors of the tuft of rushes that overhangs yonder river do not spring up immediately around their parent, the spores it has committed to the stream are sterile, and that it is not in the nature of rushes to multiply at all.

The contrast which is observed between the contagiousness of intestinal fever in the hamlet and the farm, on the one hand, and the city mansions on the other, is, I need scarcely add, in appearance only. In the country and in the city, the fever is in all things one and the same. It does not change its nature with change of place. It is as really contagious in Belgravia as it was at Chaffcombe or Penhavod. Wherever it may occur, to multiply and throw off the specific poison from which it springs, is, as we have seen, its very essence, or to speak more strictly, is the fever itself. The scale on which the poison is reproduced by this process must be at least as great in the one condition as in the other. In urban populations, the disease is even more fatal to those who become infected with it. And the bulk of new virus cast loose upon society by each individual case is, no doubt, large in the same proportion. The tribute which the sewers receive from the diseased intestine is not less profuse. Also, we have only to refer to the returns of the Registrar General to see that the *materies morbi* of which the sewers thus become the channels, however the scene of its action may be shifted, does not the less bear its natural fruit.

Cities are not so subject as country places to violent epidemics of this fever; but, taking one year with another, they furnish a larger contingent to the mortality from it. And if the anticontagionist could but extend his field of view, he might often see in the fever-stricken tenants of some court or alley reeking with sewer exhalations, the first victims of a poison which had found its way there through subterranean passages from the diseased intestine of his wealthy patient, and against the deadly power of which the rich man's household had been preserved by arrangements which his poorer neighbours had not the means to purchase.

It should not be lost sight of that in this discussion the case has hitherto been put on its lowest ground. Even were typhoid fever often really, as well as apparently, without issue, that would prove nothing as against the cases in which it is proved to be self-propagated. For if from this we were to infer that the disease is not contagious, by precisely similar evidence we must infer that *small-pox* is not so.

I do not allude here to the cases in which small-pox remains sterile, because those who come in contact with it have had the disease before, and are now proof against it, or have earned a similar immunity by the still more extraordinary condition of having been vaccinated. These cases, as showing that the propagation of contagious diseases is not only not absolute, but requires conditions of the most special kind, would be strictly in point. But I speak now of the numerous recorded instances in which small-pox has failed, or has ceased, to spread, where neither of these protecting causes were in operation, where a large prey still seemed to invite its attack, and where every condition was present, in its highest degree, that might be supposed to give effect to the poison.

The annals of the British Navy abound in examples of this kind. In evidence of this, the following characteristic extract from Dr. Lind's admirable work, 'On the Diseases of Seamen,' will suffice:—

> 'What is still more wonderful, not only the small-pox, the plague, but other contagions which I have known to rage in ships and in prisons,

> after exerting their utmost violence, will sometimes abate in their malignity, and at length stop. Have they exhausted themselves, or their subject? That they do not always exhaust their subject is plain from facts and our experience of the thing. Thus, for example, although the infection of the small-pox was pent up in the *Royal George* amongst 880 men, yet this contagion disappeared altogether at sea, and some months before she put into any harbour, after having destroyed four or five persons, and left near a hundred unattacked.' Vol. ii. p. 112.

Sir G. Blane, in relating a still more remarkable instance of the same kind, adds, that he had seen many like it.

The argument used, in regard to typhoid fever, if it were worth anything at all, would, therefore, prove small-pox to be non-contagious: a conclusion the absurdity of which is rendered palpable by the tangible form in which the small-pox poison is eliminated. Nay, if pushed to its limits, it would prove that because every seed which the thistle commits to the wind does not spring up into a new thistle—and not one in ten thousand does so spring up—thistles do not propagate by seed at all.

CHAPTER III
Nature of the Intestinal Affection

'Il faut considérer cette lésion non-seulement comme propre à l'affection typhoïd, mais comme en formant le caractère anatomique, ainsi que les tubercules forment celui de la phthisie.'[11]

—Louis

In his elaborate and masterly account of the morbid anatomy of typhoid fever, Louis divides the alterations found in the dead body into three groups, in accordance with the more or less specific relation they bear to the malady.

To the first are allotted morbid changes which have the twofold distinction of being *always* present in this disease, and never present in any other; morbid changes, that is to say, which are specific in the highest conceivable degree.

The second group is devoted to alterations, which, although not constant in this fever nevertheless occur so frequently in it, and so rarely in other diseases, as to be entitled, in a certain sense, to the rank of specific characters.

In the third and last group, this distinguished physician places all those morbid appearances which are met with as often in other disorders as they are in this one, and which possess, therefore, only a general importance.

Louis was, himself, the first to show that the well-known affection of the gut, the true interpretation of which it is the object of this chapter to discuss, not only entirely fulfills the two conditions which define the first group, but is the only overt anatomical change disclosed by the dead body which does so.

Take the diseased intestine away, and it becomes impossible, in a common outward survey, at least, to distinguish the body of a man dead of typhoid fever, from that of a man killed by many another septic poison; take away the body, but leave the intestine, and by the marks upon it, death from this fever is at once, distinguished from death from every other cause.

By every title, therefore, this disease of the intestine is as much a specific character of the fever as a peculiar pustular eruption on the skin is a specific character of small-pox, or as tubercle—to borrow Louis' own illustration—is of phthisis.

It must be obvious to all who have had more than common opportunities for the anatomical study of it, that the advanced stage at which it usually falls under observation has been a great obstacle to the formation of a true conception of its nature. Generally speaking, we see, not so much the specific disease, as the havoc it has made. It is only by tracing the morbid changes through their early phases that we are enabled to recognise their true character. At the end of the first week of the fever, these changes appear under a very different aspect from that which they afterwards present. Although death at so early a period is comparatively rare, I have seen, in the course of a pretty long experience, some ten or twelve instances in which it occurred within the first nine days, and in which I had an opportunity of examining the diseased parts.

Judging from these cases, the following are the appearances which the intestine exhibits at this stage:—A certain number of Peyer's patches, or of the isolated follicles, as the case may be, have acquired a great increase of thickness, and stand out in relief on the internal surface of the gut. In the site of these patches—to use the words of Chomel, whose description I here purposely adopt—the intestine feels as if a solid and elastic substance had been inserted between its coats. In cutting through a patch in this state, its texture is seen to be occupied by a yellowish-white cheese-like matter, of brittle consistence, about the tenth of an inch in thickness, and offering a smooth surface where divided by the knife. This yellow matter is the peculiar 'typhoid matter' whose presence is typical of the disease, and whose formation and elimination constitute the essence of the intestinal process.

In cases in which death occurs as early as the seventh day, the mucous membrane overlying the diseased patches, as well as that occupying the intermediate spaces, is sometimes found in a perfectly natural state, having its proper colour, thickness, and consistence. This is a fact of some importance, because it shows that this affection is not a disease which begins, as many suppose, in the mucous membrane properly so called, but in structures that lie beneath it; that it is not, in fine, an affection produced by agencies from without operating on the surface, but one which proceeds from a specific cause working from within. It would be easy to prove this by paramount considerations of another order, but it may not be amiss to show that we come to the same conclusion on purely anatomical grounds.

This important truth once clearly apprehended, the true significance of this morbid process seems to be no longer doubtful. When we reflect that it occupies part of a structure which, physiologically speaking, is as much the surface of the body as the skin itself; that the morbid changes in which it consists are scattered widely over this surface, with spaces of healthy structure between that, in their origin, these changes are confined to a single anatomical element; that they are attended *by the formation of a special product, the maturation and casting forth of which appear to be their natural climax;* and, finally, that they are peculiar to the disease before us, *and that disease a contagious fever*,—it is impossible not to see that the analogy already hinted at, as subsisting between this affection and the eruption of small-pox applies to more essential points than any yet mentioned, and that this disease of the intestinal follicles is, in fact, a true *exanthema* of the bowel.

In some cases, indeed, so salient are all these points of analogy, and so striking is the family likeness between the cutaneous eruption and the intestinal disease, that the conclusion just stated involuntarily starts to the mind on the first view of the morbid appearances.

In a young woman, who died under my care in St. Peter's Hospital in 1845, and in whose intestines, as now and then happens, the small circular (Brunner's) follicles were greatly predominant, and all diseased, the actual resemblance of the parts to the eruption of *variola* was so close that the student who had charge of the examination asked, in all simplicity, whether the case were not one of small-pox which had fallen on the bowels instead of on the skin. Such a fact as this shows, by the most striking of all testimony, that the analogy here sought to be established is, at any rate, not a far-fetched one.

The four accompanying illustrations [Not included, Ed.] will show how readily such an idea may arise in the mind of an unbiased observer:—

> No. 1 is from a drawing by my friend Dr. J. G. Swayne of the intestine of a young woman, who died in the Bristol Infirmary in 1850 on the twelfth day of the fever.

> No. 2, from another drawing, also presented to me by Dr. Swayne, represents the lower end of the ileum of a patient who died in the Bristol Royal Infirmary, in a very early stage of the fever. The principal interest of this specimen lies in the fact that it exhibits the morbid change in a phase in which nothing has yet intervened to mar or obscure its interpretation. It is a striking and characteristic example of the form described by Petit and Serres, under the significant name of 'la forme boutonneuse.' Unless in the larger follicles, which have begun to fret into minute ulcers, the mucous membrane is entire, and the disease is in the first stage, or the stage of development.
>
> No. 3 represents the caecum and lower end of the ileum of a patient who died of typhoid fever, in St. Peter's Hospital, now nearly thirty years ago.
>
> No. 4, as exhibiting the follicular disease in more various stages, and as being photographed directly from nature, is still more valuable than the other two. For these reasons I have chosen it for the frontispiece of this work.

In cases like this, which address themselves to the eye, the sight of a single specimen is often more convincing than the most elaborate train of reasoning.

I do not know what impression these illustrations may make on others, but to me it seems impossible to look at them without the idea of an eruption at once arising in the mind.

When we remember that this affection—to repeat the essential points once more—is characteristic of this fever: that it stands in the same relation to it, as a diagnostic mark, at least, as a peculiar pustular eruption does to small-pox:—that it is an affection which, proceeding from within, breaks out on the surface; that it results in the elimination of the morbid product, and lastly, that the product itself is the one known specific product of a contagious fever, the evidence becomes irresistible that we have here the essence of an eruptive process, whatever the name by which we may choose to call it.[12]

The history of the yellow, typhoid, matter itself, from its first appearance to its final expulsion from the body, is entirely consistent with this view of the nature of the follicular disease.

It is now well known that this matter is made up almost entirely of well-defined nucleated cells in various stages of development.

From the unique and constant presence of this matter at all points where the specific changes wrought by this fever are going on, Rokitansky has been led to the conclusion that it constitutes the actual 'materies morbi' of the fever.[13] When I first wrote on this subject, I was inclined to look upon this view as, in great degree, fanciful. Pending the more ample discussion to which I hope on some future occasion to subject it, I may state that a more mature consideration of the facts has induced me to reverse my former opinion, and to think that this distinguished anatomist will prove to be right.

In that event the demonstration would be absolute.

Assuming, for the sake of argument, the case to be already established, it may be well, before we break new ground, to see what would be the extent of the infection thus arising, and through what channels, and under what character, it might be expected to appear.

To enable us to judge of the extent of the infection, there are two elements to be taken into account: first, the amount and duration of the intestinal discharge in each case; and, second, the number of cases annually occurring. Louis made it his business to determine the former of these two points, with his usual accuracy, by the application of the numerical method. Fifteen days in mild and twenty-six in severe cases, he found to be the average duration of the alvine flux.[14] Although some little deduction from these figures must probably be made to meet our English experience, yet I should say that they are not, even here, far in excess of the truth.[15]

The number of cases, on the other hand, is approximately known. Judging from the Reports of the Registrar General, it would appear that, at the lowest computation, taking one year with another, 100,000 cases of intestinal fever occur annually in the United Kingdom.

Whether the word *eruption* be accepted or not, we come, then, to this:—that every year, in this kingdom, at least 100,000 *human intestines, diseased in the way which I have here attempted to characterise, continue, each for the space of a fortnight or thereabouts, to discharge upon the ground, floods of liquid charged with matters on which the specific poison of a contagious fever has set its most specific mark.*

This is not a theory, but the bare statement of a fact. It is the fact of facts, in its bearing on the present investigation. To obtain an adequate conception of the magnitude of the provision thus made for the work of dissemination, we must remember how infinitesimally small a dose of the poison thus deposited is sufficient to reproduce the fever, and how vast is the multiplication which, according to all reasonable calculation, this poison undergoes in every individual case. If the main conclusion we have come to in this chapter be just, the great bulk of this multiplication is represented by the intestinal discharges.

What the pustular eruption in small-pox is to the atom of inoculated virus, that, in its own degree, and most probably in no very inferior measure, is the poisonous matter thrown off by the intestinal follicles in this fever to the unit of fever poison from which it sprang. And as in small-pox the new stock engendered in a single case is often sufficient in amount to inoculate, with small-pox, myriads of other subjects, so in this fever, in severe cases, there is reason to believe that the new poison thrown off by a single diseased intestine would be sufficient in amount, *were it all to take effect,* to impart the same fever to a large community. Multiply this by 100,000 or thereabouts, and we obtain a pretty fair approximation to the annual product.

If these calculations be well founded, one thing, at least, is clear—that a disease which is endowed with such vast provisions for the continuation of its species is not likely to die out for lack of heirs.

If we now inquire into the mode, as to season and place, in which these 100,000 diseased intestines annually taint the soil of England with the fever-product, some relations of great importance come at once into view.

As to the first of these two conditions, the principal point to keep before us now is, that although some seasons, and autumn especially, are apparently more favourable to the disease than others, there is no season in which it does not prevail.

In regard to place, there is a distinction of the first consequence to be taken between cities and large towns, on the one hand, and villages and small communities generally, on the other. In villages, whatever their sanitary state, typhoid fever is often absent for many years together; in towns, above a certain size, it is never absent for a day. In the former, the infection is casual, and occurs only at intervals more or less remote; in the latter, it is perennial, and constantly going on.

The necessary consequence is, that, in every large city, the sewers are constantly exhaling. At some point or other, and generally at a great number of points at once, *effluvia directly proceeding from the most specific of all the exuviae, thrown off by the fever patient.*

In some seasons and in some city districts these effluvia are more rife than in others; but there are few or none from which they are altogether absent. In some localities they must necessarily be often present in a highly concentrated form.

To inhale sewer emanations in a great city, is, therefore, under conditions of the most frequent occurrence, *actually to inhale the very quintessence, so to speak, of a pre-existing fever.* This, whatever it may be worth, is a fact of the most real kind. It is a fact that has been singularly lost sight of in all current speculations on this subject.

Assuming the intestinal discharges to have the principal hand in the dissemination of the fever, we come at once, then, to the following deductions:—

1st. That, as a rule, this fever will spread the more, the less perfect the provisions for preventing the discharges from the human intestine from contaminating the soil and air of the inhabited area.

2nd. That where these provisions fulfill this end, the disease will show little or no contagious power.

3rd. That its tendency to run through families will oftenest take effect where there is only a common privy; least often where there is a well-appointed water closet. That this tendency will be observed very commonly, therefore, in country places, and comparatively rarely amongst the wealthy inhabitants of large towns.

4th. That, generally speaking, the distribution of the disease will be different in country and in town; that in the country, where there are few or no sewers, and where, consequently, the intestinal discharges accumulate around the infected dwelling, the disease will occur in a thickly clustered manner; that in the town where these discharges are conveyed, often for long distances, by sewers, the ramifications of which extend through large communities, it will appear in a more scattered form.

5th. That, as what the sewer receives from the fever patient is incomparably more virulent than anything else thrown off by him, the infection (until the true interpretation of the events be known) will appear, for the most part, *as if it had its source in the sewer, and not in the already infected man.*

6th. That in the country, the contagious nature of the fever will be obvious and unmistakable; but that in the town, it will most commonly be masked and obscure.

7th. That in the former, the fever will be epidemic and thickly clustered; in the latter, as a rule, endemic and scattered.

8th. That separation of the healthy from the infected will be of no avail to prevent the spread of the fever, unless it include separation from the intestinal discharges also.

9th. That, for this reason, the severest outbreaks will be seen in schools, barracks, and other large establishments, where a single common privy is often, alike, the receptacle of the discharges from the sick, and the daily resort of large numbers of healthy persons.

To appreciate the full strength of the case, we must bear in mind that, with the exception of what relates to season and place, all that is here enunciated is elicited, not from observation of the events as they really occur, but as the result of *pure deduction,* from the twofold assumption—that intestinal fever is contagious, and that the intestinal discharges contain the most virulent part of the poison by which the contagion takes effect.

These nine propositions embody, not the results of experience, but the anticipations of theory. If experience and theory happen in this case to offer an exact coincidence, is it not because the one is in reality the true expression of the other?

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In the foregoing paragraphs, I have endeavoured to show that the theory which regards the follicular disease of the intestine as the specific eruption of the fever, is in perfect harmony with many of the most characteristic facts which observation has taught us as to its mode of dissemination.

But it is not sufficient to prove a general correspondence of this kind, however close. It is important, also, to show that this correspondence is sustained when this theory is brought, face to face, with an individual case.

In 1858, a very fatal and widespread epidemic of typhoid fever, which subsequent events have rendered ever memorable, occurred in the town of Windsor.

The leading circumstances of the outbreak were investigated at the time with great thoroughness by Mr. Simon and Dr. Murchison. For the full particulars of it, I must refer the reader to the accounts of it given to the public by these two writers.[16]

It will be sufficient, here to say that the net result of their investigations was to establish, not on general grounds merely, but by data of a perfectly scientific order, a fundamental connection between the outbreak and the state of the Windsor sewers at that time.

The considerable scale on which the phenomena occurred,—the accuracy with which they were recorded, and the remarkable precision of the facts, all give to this case a special fitness as a standard, whereby to test the truth of theoretical views.

But, in the selection of this case, for this particular purpose, I have been actuated by a still stronger motive.

I have chosen it not so much for the exactness of the data, as for the striking way in which these data were considered, at the time, to confirm the modern doctrine as to the cause of typhoid fever, in opposition to the doctrine of self-propagation.

In the first place, they were supposed to put, on the authority of facts which could not be misinterpreted, a final and absolute negative on the notion that the transmission of a specific poison from the sick to the healthy has any considerable share in the dissemination of this malady. The indications of contagion, if existing at all, were reported to be insignificant, and by some were held to be altogether doubtful. In seven instances in which the operation of this cause was at first accused, the evidence was said to have entirely broken down on a closer scrutiny.[17]

It seemed, indeed, to be generally felt that, in the events of this epidemic, the doctrine of contagion, as applied to this fever, had received its *coup de grace*. On the other hand, the pythogenic or 'putrescence' theory, as directly opposed to that of contagion, was thought to have found in the same events an equally final and decisive proof. Here, at any rate, sanitarians argued, was evidence, which none could gainsay, of the production of typhoid fever, on a large scale, by the compounds which mere putrescence breeds in sewage. The facts were as simple and clear to apprehend as they appeared to be severe and binding. By a large and influential school the case is still triumphantly cited in vindication of both these positions. And, that the Windsor epidemic proved, with a clearness and precision not often witnessed before, that typhoid fever may be widely disseminated by a poison issuing from sewers, there could be no doubt. This it was that constituted the special value of the case. But that the morbific agent was bred of mere chemical change occurring in the ordinary contents of sewers, and not in the living and already infected body, this, of all cases, was surely the least fitted to prove. In forming the conclusion that it was so bred—whole order of facts had been left entirely out of view.

It has already been observed that this epidemic was a considerable thing. The total number of attacks was supposed at the time to exceed four hundred. Mr. Simon, apparently not without reason, believes this to have been an overestimate. As, however, the deaths were thirty-nine, and as we know, from very large averages, that the proportion of deaths to recoveries is about one to nine and a half, the popular figure was probably not far in excess of the truth. At any rate we shall not err if we assume that at least three hundred and fifty genuine cases of this fever happened in the town.

Now, it is well known that the specific disease of the intestinal follicles of which it is the object of this chapter to ascertain the true type, is an inseparable accompaniment of the fever. In the course of the epidemic, therefore, three hundred and fifty intestines, affected, more or less severely, with the typical disease figured in the foregoing plates, discharged their specific exuviae into the Windsor sewers.

For a period varying from a fortnight to a month, each one of these three hundred and fifty intestines was pouring—often, no doubt, in copious floods—the most specific of all the fever products *into the very channels which were proved to be giving issue to the fever poison.* From the mouths of all these channels, emanations directly proceeding from the fever discharges must have been constantly exhaling into the houses in connection with them. This, whatever it might be worth, was as real a fact as any in the history of the epidemic. If the views I have ventured to propound in these pages be true, it was the most important of all. Under any view, it was obviously a fact that had the most imperative claims to be considered at least, in any adequate discussion of the causes of the phenomena. And yet, strange to say, in the two otherwise very elaborate essays which have been published on this epidemic, it does not once appear as an element of the problem. Perhaps it is still more strange, as reflecting the state of medical opinion on this subject at that time, that at the meeting of the Epidemiological Society, at which one of these papers was read and discussed, there was no one present who undertook to repair the omission.

If the evidence already here advanced be worth anything, there can be no doubt as to what was the part played in this memorable outbreak by the incessant flooding of the sewers which were disseminating the fever with the specific fever discharges.

In the first place, in seeking to determine this point, we must never lose sight of the fact, already established, that the fever in question is a self-propagating fever.

For proof of the reality of this property, we need not go beyond this very case. Singularly enough, it is admitted, even by some of those who most repudiated the idea that contagion or self-propagation had any important hand in the events, that in four instances, if not more, there was decisive proof of the communication of the disease from the sick to the healthy. But this is, surely, a very important admission. It might not unreasonably have occurred to any one, that here, perhaps, was the one fact by whose light all the others should have been interpreted.

As regards this fever, I endeavoured to show, in the last chapter, what propagation by contagion really implies. If there be one thing more certain than another in the history of the disease, it is, that this property is not an accident or epiphenomenon—not a thing that may be put off or on, but an attribute which springs out of conditions that touch its most intimate essence. To reproduce and cast off a specific morbid poison is, as I have already observed, inherent in its very nature, or, in other terms, is the disease itself.

But, if this be so, the only other element needed to explain, in the most simple way, everything that occurred at Windsor is, that the affection of the intestines which accompanied the fever should be what the illustrations attached to this chapter represent it to be, and that the excreta from it should be charged (as under this view they necessarily would be) with the specific agent by which the contagion takes effect. If these excreta contain the fever-virus, it is certain that the sewers were being incessantly impregnated with it, and, being so impregnated, it is equally certain that they could not fail to be the principal media for the propagation of the fever. So that the events, as they actually occurred, are not only fully explained on this theory, but might have safely been predicted.

To hold, under these circumstances, that the fever which the sewers were communicating was not the effect of the specific fever-poison with which they were so largely supplied, but of some perfectly undefined and purely hypothetical compound which putrefaction is supposed to extricate from common sewage, seems to me to be nothing less than to invert all the rules which philosophy and experience have united in showing to be essential to a true induction.

To place on unassailable ground the theory of the Windsor fever which I here venture to substitute for that originally propounded, it is, however, necessary to show not only its own fitness, but the untenability of the rival, and only other possible, view. Without anticipating the more complete discussion to which I purpose [*sic*] to subject this branch of the question, I may remark that, under that view, two great difficulties at once suggest themselves.

Assuming, for the sake of argument, that in the great majority of cases the fever was caused by the common pythogenic or putrescent compounds which exist in all sewers, what are we to say to the cases which sprang from contagion? Had the poison two entirely distinct sources? Bred in the most intimate recesses of the living body, by that most specific of processes which constitutes the fever itself, was it also bred by the common chemical changes which occur in mere 'filth'? To establish a supposition so improbable, on its very face, as this supposition is, it is essential that the evidence should be not only open to no ambiguity, but of a nature to preclude every other possible explanation. How far this was from being the case we have already seen. We know, in fact, that all the while other conditions were in operation, which might possibly, at any rate, explain, in the most natural way, all that happened, and render the supposition in question altogether gratuitous.

The nature of the other difficulty referred to can only be seen by enlarging the field of view.

One of the great characteristics of the Windsor outbreak was the intense power with which, wherever it took effect, the fever-producing cause was acting. Even in the comparatively well-appointed houses of the middle and upper classes it was no uncommon thing for four or five inmates to be struck down at once, or in pretty close succession. But if this were the effect of common sewer emanations, how can it be reconciled with the fact that at the very same time this fever was entirely absent from other places without number, where, nevertheless, there was the evidence of a sense which cannot deceive us, that such emanations were in the highest degree rife?

During the very period when the Windsor epidemic was at its height, I was in the habit of visiting several thickly peopled courts in Bristol, where the atmosphere of the houses was charged with sewer effluvia to a degree that would not be endured, for a day, except by persons who were bound by the iron chain of poverty to a fixed spot. And yet, all the while, in not one of these courts did a single case of fever arise. Hundreds of other medical practitioners could, I doubt not, bear the like testimony.

The intense contrast between the results in these two cases showed by evidence of peculiar cogency and force that some difference must have existed in the nature of the effluvia. The miasm that, on every hand, was laying whole families prostrate with fever, and the miasm that, at the very same time, was for months together causing no fever at all, must have differed in some essential thing.

Under the supposition that in the one case it was the vehicle of a contagious virus, while in the other it consisted only of putrescent compounds, the two orders of events were at once explained. On the supposition that putrescent compounds are the actual cause of fever, they are absolutely inexplicable. Adopt the one view, and all is consistent and in harmony with what we know; adopt the other, and everything is inconsistent and at variance with what we know. The events no longer cohere: we have to take up on theory for one set of facts, and another theory for another set; to explain how it was that the fever sprang sometimes from the sewer and sometimes from contagion; to show why, while it was so deadly at Windsor, it was entirely absent from places where the sanitary condition was fully as bad. In one word, we have to reconcile irreconcilable things.

Before I leave this topic, I have one more remark to make. If the version of the Windsor fever here given be the true one, we need go no farther for evidence to show that the intestinal discharges are not only contagious, but incomparably more so than anything else cast off by the sick. We have seen that out of the whole 350 or 400 cases, there were only four that could be traced to direct *personal* communication. Even in these four it does not appear that the disease might not have been propagated by what was thrown off by the bowel. In the remaining 340 or 350 the poison was transmitted through the sewer; or—to state the fact in other words, for now I feel we are entitled to do so—the fever was the work of the intestinal virus.

The whole history is, in short, summed up in the two orders of facts which are here contrasted. The cases of proved contagion showed by decisive evidence what was the nature of the law by which the fever was being multiplied; the propagation of the fever through the sewers showed, by evidence equally decisive, from what particular surface of the infected body the material issued by which the law was taking effect. Owing to a peculiar combination of circumstances, both these points were brought out with the force and clearness which are generally only met with in the results of experiment. Indeed, had it been possible to furnish experimental proof of the two leading positions which it is one of the chief objects of this work to establish, the evidence in their favour could scarcely have been stronger than that which was here furnished by the natural order of events.

The second great point to which, before I conclude this chapter, I wish for a moment to draw attention, that the excreta to which all these fatal prerogatives are assigned are, on their issue from the body, entirely within our power. I shall show, in the course of these pages, that by placing a sufficient measure, of a caustic solution of chloride of zinc, or an equivalent quantity of any other powerful disinfectant in the night pan before it is used by the fever patient, the intestinal discharges may be entirely deprived of their contagious powers. I shall give in future chapters the evidence on which this statement is founded, but I believe the inference to be sure, that if the simple measure here referred to were universally carried into effect, typhoid fever, in so far as it is propagated by sewers, would at no very distant time become extinct. To insure the universal adoption of a measure even so simple as this would, however, require a degree of co-operation amongst medical men, and a degree of zeal and intelligence on the part of the attendants on the sick, which, at present, at least, I fear we have no title to expect. But, although we may not attain to so desirable a consummation as this, we may come indefinitely near it. At present, the great bulk of what escapes from the intestines of fever patients in this and other countries, is, too often, let loose upon society without the slightest precaution being taken, and we see with what results. I trust the time is not far distant when to allow these matters to pass into the cesspool or sewer in full possession of their deadly powers will be looked upon, not merely as a careless, but as a highly culpable act.

CHAPTER IV
Nature of the Relation of Typhoid Fever to Defective Sewerage

'In the Appendix to the Fourth Report of the Poor Law Commissioners, it is stated by Drs. Arnott, Kaye, and Southwood Smith, that the malaria arising from putrefying animal and vegetable matters produces typhoid fever. Although I highly, respect all these gentlemen, and approve of the practical inferences which they draw from that opinion, so far as it goes, because I have no doubt that vitiated air, like all other causes that weaken the constitution, favours the diffusion of fever, yet I cannot subscribe to their opinion that this cause is adequate, of itself, to produce a contagious fever.'

—Alison

If the argument in the last chapter as to the nature of the typhoid intestinal affection be sound, it supersedes, in great degree, at least, the need of further evidence, as regards the fundamental part of the problem I am endeavouring to solve.

For, once [we, Ed.] admit that this affection is the specific eruption of a contagious fever, and all the main positions taken in this work, as to the connection of this fever with defective drainage—[it, Ed.] would seem to follow as a matter of course.[18]

Thus stated, the question is purely one of pathology, and what the physician has to ask is, whether this pathology be true or not.

If it can be proved not to be true, it falls to the ground, and all the inferences that hang upon it, fall with it.

In the present chapter I shall endeavour to show, *as a matter of fact*, that, whether we accept this theory of the intestinal affection or not—that, whatever the view we take of its nature—the intestinal discharges constitute the material by which the fever is mainly propagated,—and that this, and this alone, gives the key to the relation which the spread of this particular species of fever bears to sewerage.

That typhoid fever is actually caused by a poison which sewers and other cloacae often contain or carry, is a proposition which no English physician will dispute.

Were there no other evidence, the history of the Windsor Fever referred to in the last chapter, would, of itself, be sufficient to establish the fact.

As this fact, however, is quite fundamental to the present inquiry, it must not be allowed to stand on the footing of a mere article of popular belief, but must be made the subject of scientific demonstration. At the risk of being redundant, therefore, I will venture to cite another outbreak in illustration of it, in which the events, regarded in the light of scientific data, leave absolutely nothing to desire.

In the autumn of 1847, an outbreak of fever occurred in Richmond Terrace, Clifton, which acquired great notoriety, at the time, on account of the suddenness, extent, and severity of the visitation.

The terrace in question is built somewhat in the form of a horse-shoe, and consists of thirty-four houses of a good class, occupied by persons in a genteel rank of life. At the end of the terrace there is a pump, from which, at that date, the inhabitants of thirteen houses drew their drinking water. In the latter end of September it became evident that this water was tainted with sewage. The fact first made itself known by a characteristic taste and smell in the water, and was afterwards further verified by an examination of the well and discovery of the actual leakage. Early in October, typhoid fever broke out nearly at once *in all the thirteen houses in which the tainted water had been drunk*. In almost every house of the thirteen, two or three persons were laid up, and in some a much larger number. Amongst others, the case of a school for young ladies was very striking. The first to suffer in the school was the lady of the house. She was taken ill on the first Monday in the month. Four of her pupils were seized on the following day; and before the end of the week, the mistress, six school-girls, and two maid-servants, were all in bed with the same fever. In the beginning of the week following, two more were added to the list. Three children who were sent home on the first outbreak of the disorder, and three others who remained at the school, were the only persons who escaped.

The houses in which the same specific fever thus simultaneously broke out on so large a scale were many of them far apart in the length of the terrace, and their inmates were, for the most part, not in the habit of personal intercourse. The other families on the terrace, *living side by side with these*, continued all the while to be perfectly free from fever. The only important circumstance in which those who suffered so severely differed from those who did not suffer at all, was that the former had drunk of the tainted well, and the latter had not.

Only a few doors from the school already mentioned there was another girls' school, with about the same number of pupils. In all that related to their internal economy the two schools were exactly alike; but while, in the one, eleven persons out of seventeen were struck down with fever, in the other there was not a single case. The one was supplied with drinking-water from the poisoned well, and the other from an entirely different source. The circumstances gave to the contrast, here, all the force of an experiment. In complex questions it is not often, indeed, that even experiment yields results so clear and precise.

Amongst the sufferers, at Richmond Terrace were nine servants, who were removed to the Bristol Infirmary soon after being attacked. To make the case complete, I have only to add, that all nine presented, in full development, the diagnostic marks of this species of fever. Two of the number, who were my own patients offered perfectly typical specimens of the disorder. In two others, who died, the small intestine was crowded with the ulcerations which are characteristic of the disease.

The next case will take us a step further, and is besides so important, in all ways, that it shall have a section to itself.

Outbreak of Typhoid Fever at Cowbridge in 1853—Propagation of the Fever by Fever-Tainted Drinking Water

In the month of November 1853, it being Cowbridge Race week, two balls were held on two alternate nights at the principal hostel of that little Welsh town.

These balls were attended by about 140 persons, the greater number from different parts of Wales, but some from Gloucester, Somerset, and other distant counties.

Almost immediately afterwards, a number of these persons were seized with typhoid fever, and as many as eight died of it. Among the sufferers there was a considerable proportion who had never been in one another's company, except in the Cowbridge ball-room. It is clear, therefore, that they had in some way contacted the fever there; and that the typhoid poison was present at this hostel in no common degree of force and intensity. It is not recorded that fever was specially prevalent at the time in the neighbourhood; and, with the exception of one or two persons who lived in the house, those who attended the balls appear to have been alone attacked.

An occurrence so painfully striking, and in all ways so remarkable as this, naturally attracted great attention at the time, and an inquiry was held, with a view to discover the cause of the calamity. The only sanitary defect elicited by this inquiry, in explanation of so terrible an outbreak, consisted in the fact that 'the supper-room was merely a temporary transformation of a loft over a seven-stalled stable,' and that the passage between it and the ball-room was partly built over a large tank which collected the water from the roof of the house.

About fifteen months after this outbreak occurred I was called to Cowbridge to a case of typhoid fever which had come down by direct lineal succession from one of the original sufferers; and I took the opportunity of ascertaining as well as I could, both from the people of the hotel and from the medical man consulted on the occasion, the leading circumstances of it.

First in order came the all-important fact, which had not been disclosed to the gentleman who originally reported on the outbreak, that there had been a case of typhoid fever in the hotel immediately before the balls were held.

The disease occurred in the person of a gentleman visiting the hotel, and who was laid up there for some time with it. A day or two before the balls, although not yet fully convalescent, he left the house on account of the approaching festivities.

As none of the ball-goers had been in the presence of the sick man, it was obvious that they did not contract the fever from direct personal infection. There was no reason to believe that the infection was communicated through the air, as no offensive smell in the ball-room, or, indeed, anywhere in the house, was noticed by the guests. From this and other considerations I was led to infer that drinking-water was the most probable vehicle of it.

A visit to the courtyard of the hotel left in my mind no doubt that this was the true view of the case. The cesspool and drain, which I was informed had received the bulk of the diarrhoeal discharges from the fever patient, was at the time of the outbreak so near to the well, that, under the conditions of soil and locality, percolation from one to the other was almost inevitable.[19] I further learnt, from persons who were present at the balls, that, as is usual on such occasions, many drinks—lemonade among others—were largely supplied there, and freely drunk.

This much, then, was sure—that a considerable number of the persons who attended the balls drank freely water from a well in close proximity to a receptacle which, for a considerable time, had received the specific excrete from the diseased intestine of a fever patient.

To complete the demonstration, nothing more seems needed than the fact that within a few days a considerable number of these persons were found to be infected with the same fever. It is seldom that, in the difficult work of tracing the causes of disease, we can succeed in bringing fundamental relations so close together as these. In short, the case, strikingly peculiar in its circumstances, was, in another sense, one of a category of which examples are now being continually recorded.

The main facts established, there are one or two collateral points almost equally deserving attention, which it may be well to note at once.

The first is the very large proportion in which the guests were infected. Of the persons who attended the balls, there is reason to believe that from forty to fifty suffered—a truly remarkable proportion when it is borne in mind that many, probably, drank no water at all, or only water that had been boiled.[20]

The second point which this outbreak illustrates, in a striking way, is one to which I have already referred, viz., the very prolific nature of the typhoid poison.

The water which gave fever to all these people could not have amounted to more than a few gallons, at most. The exact cubic contents of the total well-water I do not know, but from fifty to a hundred cubic feet would probably be a moderate estimate for it. What, if all the rest were as potent—and this might well be—as that which was actually drunk? Who shall say what number of persons might not have been infected with the same certainty as those on whom the water acted with such deadly effect?

But when we consider, in addition, that the great bulk of the poison cast off by the fever patient must have remained, after all, in the cesspool, the number of contagious units contained in the whole quantity is more easily imagined than calculated. In another chapter I have shown it to be probable, reasoning from the analogy of other contagions, that the new virus engendered in a single case is often sufficient in amount, could it all take effect, to infect a large community. Striking illustrations of this great truth have already been recorded in former pages; others will occur as we proceed; and in the current Sanitary Reports examples of it are, of late especially, almost constantly appearing; but among them there is, perhaps, scarcely one so telling as that which is afforded by this Cowbridge case.

Another point has come to my knowledge subsequently to the visit at which I learnt most of the particulars hitherto given. In the course of the nineteen years which have since elapsed, I have been consulted, professionally, by eight persons who caught fever at these balls. From them I learnt that the one peculiarity which distinguished their illness was the extreme shortness of the time which intervened between the reception of the infection and the actual development of the fever. In four days, all eight had already taken to their beds, two were laid up on the second day, and two others were seized with violent vomiting and purging the day after the balls, and went straight into the fever from that time. Indeed, so rapidly, in many, did the illness supervene, that the outbreak, at first, was supposed to be, not one of fever at all, but the result of common chemical poisoning.

I have observed a like shortness of incubation in many other cases of typhoid from drinking infected well-water, and believe it to be due to the high degree of concentration of the poison, which must result from its being cast out into a medium of fixed and limited amount.

The fact is all-important to the true interpretation of such cases.

One consequence of it is, that in communities living in a single establishment, such as schools, workhouses, and other places under like conditions, the first case of a series propagated in this way is separated from those which are the actual offspring of it by so short an interval, that they are looked upon as if they were simultaneous, and are often erroneously considered as the work of a common cause.

As regards this point, however, everything must depend on the nature of the communication between the cesspool or drain, and the well. Where this communication is large and direct, the succession of events is rapid; but where it is by gradual percolation through strata of some depth, a considerable time may elapse after the poison is discharged before it can again reach the human stomach. A heavy fall of rain sometimes appears to be the determining incident.

It seems probable, also, that a suddenly-increased draught upon the water of a well, by causing a correlative inflow from surrounding tainted strata, may also hasten the result.

Outbreak of Typhoid Fever at Kingswood in 1866—Propagation of the Fever by a Fever-Tainted Brook

On October the 24th, 1866, my friend Dr. H. Grace, whom I had met on other business, told me that, if I had half an hour to spare, he would show me a striking illustration of my views on the spread of typhoid fever.

The temptation was too great to be resisted; so, jumping into his dog-cart, we presently pulled up in front of two labourers' cottages built in a single block, by the roadside. These cottages may be called, for convenience' sake, Nos. 1 and 2.

In the form of a lean-to against the gable end of No. 2 was a privy, which served in common for the inmates of both dwellings.

Through this privy there flowed, with very feeble current at that time, a small stream, named the Waynebrook, which formed a natural drain for it. Having already performed the same office for some twenty or thirty other houses higher up on its course, this stream had acquired, as was patent to more than one sense, all the characters of a common sewer, before reaching the cottages in question. From this point, after skirting the high road for about forty or fifty yards, it passed into a field, and crossing, now as a covered drain, now as an uncovered ditch, some three or four meadows, the stream came into the open again in a large court occupied by two other labourers' cottages and some farm buildings. These two cottages may be conveniently called Nos. 3 and 4.

The sanitary relations which the stream held to their inmates was an exact repetition of that which obtained in regard to Nos. 1 and 2, already described.

Passing through the court uncovered, it acted as a drain to a small privy, common, as before, to both cottages.

I did not measure the distance which separated these two little homesteads, but I judge it to be somewhere about a quarter of a mile, as the crow flies.

The four cottages thus situated were the scene of the series of events which Dr. Grace was anxious to bring before me.

The outbreak began in the person of the father of the family living in No. 1. There were two circumstances attached to this man which made his case different from that of any other member of his own or his neighbour's household.

1st. He was the only one of the group whose way of life took him away to the neighbouring city; and 2nd, he was the only one who, was known to have been exposed to the infection of typhoid fever.

Having a horse and cart, he plied a small trade with Bristol, partly as hawker and partly as huckster. His chief business in the city lay in the filthy back-slums of St. Philip's, where, for some time immediately before his illness, typhoid fever—as I can affirm from my own observation—was epidemic. Whether he got his fever here, it is, of course, impossible to say with absolute certainty, but that in the course of his business he must have been largely exposed to its specific infection there was no doubt.

That his disease was contracted away from home was further indicated by the fact that when he was stricken all the other inmates of the two cottages were, and, indeed, continued for some time after, to be, in their usual health.

His attack proved to be severe and protracted, and for a considerable time was attended by profuse diarrhoea. As a matter of course, all the discharges were thrown into the common privy. In this way, for more than a fortnight, the stream which passed through it continued to be daily and largely fed with the specific excrete from the diseased intestine of the patient.

Some weeks passed away thus, without any fresh incident; but, in the latter end of the third, or beginning of the fourth week which, as M. Piedvache has justly observed, is about the time when the contagion of this fever generally begins to show itself in fresh crops of the disease—a new order of events occurred.[21]

Several persons were simultaneously attacked with the same fever in all the four cottages.

Not, be it observed, in Nos. 1 and 2 merely, whose inmates might be described as living in more or less contiguity to the already infected man, but in Nos. 3 and 4 also, nearly a quarter of a mile away.

Within the space of a few days Dr. Grace was attending quite a cluster of cases in each of the four, and before long the majority of the persons living in them were in bed with the fever.

One fact more must be recorded to render the history complete.

From first to last, the outbreak was confined to these four cottages, and there was no other case of typhoid fever at the time in that neighbourhood.

These events speak for themselves.

If we look at them by the light of what has gone before if, especially, we bear in mind the established fact that, in some way or other, this fever has the power to propagate itself, there can be no reasonable doubt that the second crop of cases was the offspring of seed cast off by the first sufferer.

But if this be so, the circumstances of the outbreak in the two lower cottages, Nos. 3 and 4, show by the most striking evidence what was the particular form under which this seed was liberated.

The significance of these circumstances will be appreciated at once when it is added, that those who were attacked in this particular outbreak had not only held no intercourse of any kind with the inmates of Nos. 1 and 2, but had not the remotest suspicion of the origin of the deadly pest which had appeared thus silently in their midst.

The little stream laden with the fever-poison cast off by the intestinal disease of the man who had been stricken with the same fever some weeks before, was the only bond between them.

We have already learnt to see in this disease of the intestine the specific eruption of a contagious fever; we here see, as in small-pox, and other contagious fevers, the poison shed by this eruption producing fresh fruit.

But if the remarkable history here related shows with the utmost clearness that sewage when charged with the specific excreta of typhoid fever is all-potent in the propagation of that disease, it appears to me to show with equal clearness that sewage not so charged has no power of the kind.

While Dr. Grace was seeing his patients in Nos. 1 and 2, and I was standing outside, a gentleman on horseback drew up, and addressed me in these words—

> 'Ah, I see what you are upon. The only wonder is, that all these poor people have not died of fever long ago. For, any time these last six years, but in summer especially, to anyone coming down this lane, the stink has been enough to knock a man down.'

But although—so to speak—strong enough to knock a man down it had failed all these long years to cause a single case of fever.

How, if sewage emanations be as potent to cause typhoid fever as many teach, can this possibly be explained?

This failure, to recur to an argument used once before, could not have been because the seasons had not been favourable to the development of the pest, for within this period this fever had more than once committed great havoc in the same parish. It could not have been that the little community who were now suffering so severely from it were proof against it, for as the event proved they were only too susceptible.

The very magnitude of the contrast between these many years of past entire immunity from fever, and present great prevalence of it is, surely, in itself, decisive of the question. But there was no need of traveling back in time to give point to this antithesis. At the very date when the events were occurring, all the elements of this contrast were present on the spot.

I have already stated that before reaching cottages Nos. 1 and 2, the stream had served the office of common sewer to some twenty or thirty houses higher up. But while in Nos. 1 and 2 and in the two cottages below them, nearly every inmate was stricken with fever, in not one of the thirty houses above these, was there, from first to last, a single case.

It was down the stream that the seeds of the plague flowed.

Higher up, the stream was common sewage only; lower down, it was sewage *plus* the specific excrete of the fever patient.

Hence the cardinal difference in the fate of those who were exposed to its emanations in the two situations.[22] The only inference that it seems possible to draw from these facts is, that while sewage charged with the specific fever-poison is all potent in breeding fever, sewage not so charged has no power to breed it at all.

About two years later, Dr. Grace took me rapidly over the ground of another outbreak, occurring in the same neighbourhood, in which there appeared to have been an almost exact repetition, on a larger scale, of the incidents just related.

In this case, also, a small rivulet was the carrier of the infection. Rising, like the Waynebrook, near the summit, but on another slope, of Kingswood Hill, and passing thence through the small village of Hanham, this rivulet winds its way through a valley about a mile long, until it discharges itself into the Avon.

All the way down the valley, below the village, its banks are studded with cottages, which are to the stream as so many beads strung on a string.

For some of these cottages the stream is the actual sewer; others, which are a little farther off from it, still, for the most part, deliver the excreta of their inmates, and other refuse, more or less directly into it.

Along the whole line of watershed, the stream is, in fact, the natural drain of the valley.

The first case of the series occurred in a cottage, which, for convenience sake, we may call No.1, and which stood at some little distance perhaps a hundred yards, or more—from its bank. The next cottage in which the disease appeared, and which we may call No. 2, almost immediately overhung the stream. That the infection was actually conveyed from the one to the other there was no absolute proof. But while the circumstances were such as fully to justify this view, the improbability of any other was extreme.

The numerous class who confess their belief in the powers of sewer gas can have no difficulty about the origin of the first case.

The subject of it had been employed, for the two months immediately preceding his attack, *as a workman in the Bristol sewers.*

His case was severe and protracted, and was attended with much diarrhoea.

It is important to observe that at the date of his seizure there was not only no other case of typhoid fever in the neighbourhood, but that, for many years before, the whole of this valley had been entirely free from it. Specially, I may mention that at the very time when on the Waynebrook, about a mile away, this same fever was rife, in the outbreak just described, there was no trace of it here.

In the Hanham Valley, as in that outbreak, some weeks passed away after the seizure of the first subject, without any fresh incident.

At the end of that time, almost simultaneously, new cases of fever sprang up, not only in No. 1, but in No. 2 also, the inmates of which appear to have held no personal intercourse with it. From this date the fever may be said to have been fairly planted on the stream, and, for weeks together the current was fed with large and increasing doses of the fever excreta.

I do not know the events which followed with sufficient accuracy of detail to speak of them in other than general terms. It is sufficient to say, that before the tragedy ended, this same specific fever, descending step by step, broke out in some twenty or thirty cottages, down the banks of the stream which bore the specific exuviae from it. So long as this stream conveyed common sewage only, it had been powerless to cause fever; but when it became charged with the fever poison, a large community were speedily infected by it.

I may observe in passing, that these two outbreaks not only show fever to be self-propagating, but, like the events which occurred at Cowbridge, prove it to be very prolific.

They not only give the key to its wide dissemination, but offer a perfectly adequate explanation of it.

Give to any disease this faculty of self-multiplication—the power to cast off seeds and breed new crops, and you give it the power to perpetuate itself, and, where the climatic conditions allow, to spread widely over the earth.

It is by this power, and by this alone, that the other contagions keep up their kind, and have come, in course of time, to infest large portions of the globe.

Nay, it is—by the very same power, that of self-multiplication—that the living species, which people it, have come down to us, and maintain their succession among us.

Typhoid Fever in Schools and Other Public Establishments

The conclusions to which the four remarkable outbreaks just related so clearly point, are entirely borne out, as I have already more than once shown, by the general history of typhoid fever.

But the illustrations of these conclusions furnished from time to time by schools and other large public establishments are so striking, and the lessons they teach are, practically, so important, that I may be pardoned for citing one or two of which I possess records.

Some twenty years ago or more, I had occasion to visit a large public school in the south of England, where, a short time before, typhoid fever had made great havoc.

As nearly always happens under such circumstances, the fever had begun by one or two straggling cases, followed, after some little time, by the seizure of a large number of inmates at once. On the strength of the general experience in such matters, the state of the common latrine, which was very defective and highly offensive, was at once fixed upon as a sufficient explanation of the calamity. As the boys who took the fever *were separated from the rest the moment they fell ill,* the operation of contagion was supposed to be entirely excluded, and the case was accordingly quoted, at the time, not only as opposed to contagionist views, but as a flagrant illustration of fever on a large scale caused by miasmata actually generated in a common sewer. But a closer scrutiny was fatal to this view of the case. In the first place, the cloaca, although sufficiently offensive, was in no worse state than it had been in for many months before, during the whole of which time no single case of fever had occurred. That what had been so long harmless should have become suddenly so deadly, of itself implied the introduction of some new element. On the other hand, in considering events of this kind, we cannot lose sight of the great fact that this fever is an essentially contagious fever. Those who came to the conclusion, that in this particular instance it had not spread by contagion, had overlooked the all-important circumstance that, although the *persons* of the sick were secluded, the locality which by common consent had been fixed upon as the very focus of the mischief had continued to be flooded daily by the most specific of all the emanations from them. I ascertained on inquiry that *the intestinal discharges from the fever patients still found their way to the common receptacle;* so that, on the very principle of contagion, the boys who continued to use this receptacle ran a far greater risk of catching the fever than if, without resorting to it, they had actually passed their time in the sick chamber. Looking at the facts as a whole, therefore, and interpreting them by the light of other evidence, the conclusion seemed to be irresistible that the tainted latrine, to which everything pointed as the chief agent in spreading the fever, gave the disorder, not because it was exhaling *pythogenic* or putrescent compounds, but because it had become impregnated with the actual fever-poison.

A precisely similar order of events occurred, in the autumn of 1842, at the Female Orphan Asylum, Ashleyhill, near Bristol. This asylum is spacious and well built, and stands on a healthy site. At the date of the outbreak it held exactly fifty inmates. The fever began in the first week of August, with a single case, in the person of one of the girls. About twelve days before her attack, the orphans had spent a whole day out, and it was the matron's opinion that this girl had, by some chance, contracted the fever on that occasion. There were many things, indeed, to favour the conjecture. Amongst others may be mentioned the fact that, being in the enjoyment of her usual health up to the day of the holiday, she began to droop almost immediately afterwards. As soon as she was laid up she was placed in the sick-room, away from the rest, except one or two invalids, who, at first, shared the apartment with her. At a later period, when cases began to multiply, a special ward was set aside where all fever patients were kept, in strict seclusion from the moment of their attack, in the hope of staying the spread of the disorder. It was not until early in September, when the first patient was already in the fourth week of illness, that the second case occurred. This was soon followed by others, which came in, one by one, in pretty quick succession, until the beginning of November, when the disease ceased to extend. By that time, twenty-three of the fifty inmates had been attacked by it. It may be well to add, that in the greater number diarrhoea was a very troublesome symptom, and that in the only fatal case the characteristic ulcerations of the intestine were found by my friend, Dr. Swayne, by whose kindness I was enabled to take part in the post-mortem examination.

There was nothing in the sanitary condition of the establishment to account for so severe an epidemic of fever under the popular view of its causation. The house was scrupulously clean, the drinking-water pure, and, with the qualification to be presently made, there were no bad smells about. There were in the construction of the latrine two points to which, no doubt, serious exception might be taken. In the first place, it was a common privy, and not a water closet; in the next, the little room in which the eight or nine *sedilia*[23] were, was close and ill ventilated. A dead wall stood almost immediately in front of the door, and the window did not admit of being opened. Whoever entered there, necessarily breathed for the time an atmosphere highly charged with exhalations from the foul excreta which it is the office of such places to receive.

But that this state of things was of itself powerless to cause the fever, was proved in the most striking way by the history of the place. For nearly twenty years this latrine, such as it then was, had served the needs of the whole establishment. Nothing had happened to derange either its structure or its functions. It was not more offensive now than it had ever been. But up to the date of this outbreak, no single case of fever had occurred to the long succession of orphans who had resorted to it. To suppose that an agency which for so many years had not caused one case, should now cause more than twenty at once, would be on its face absurd. The extreme contrast between present great prevalence and past total immunity, was, in this instance, also, clear proof of the introduction of a new element.

We need not seek far to know what that element was. Had not the conclusion been forced upon us by the absence of any other rational explanation, as well as by the whole order of events, it would have been plain, from other considerations, that this fever was being propagated here by the same law as that by which it was propagated at Loosebeare and at Chaffcombe—that is to say, by contagion.

But if propagated by contagion, there could be no doubt as to the way in which the contagious germ passed from the sick to the healthy. *Kept in strict separation from one another, as far as their persons were concerned, the common privy was almost the only connecting link left between them.* A new event had lately occurred in the history of this cloaca. For the first time since its construction it had become impregnated with discharges from the diseased intestines of fever patients. The fifty persons who daily entered there, now breathed exhalations from these discharges in a high degree of concentration. What wonder if twenty-three of the fifty should pay the penalty in an attack of the disorder.

The history, of which two examples have here been given, is, in its main features, a very common one. In the records of the schools, workhouses, barracks, and prisons of this and other countries, a great number of strictly analogous cases are to be found. Outbreaks of Asiatic cholera, which, in all essential conditions, are the precise counterpart of these outbreaks of fever, are also of common occurrence in the same establishments.

The conditions under which these outbreaks occur have a peculiar interest for two reasons: first, because, in many of them, the early separation of the sick has been, on principle, rigorously carried out; and, secondly, because, *in spite of such separation*, no other communities have ever offered such instances, as these, of rapid and wholesale infection.

I have already endeavoured to show, elsewhere, that in cholera—and the principle applies with the same strictness to typhoid fever—the solution of this enigma is to be found (in many instances at least) in the defective condition of some latrine, which is at once the receptacle of the discharges from the sick, and the daily resort of the healthy.

CHAPTER V
Conditions Attaching to the Contagious Agent As It Exists in Media External to the Body

'The positions of science must be tried in the jeweler's scales, not, like the mixed commodities of the market, on the weighbridge of common opinion and vulgar usage.'

—COLERIDGE

It is plain, from what has gone before, that the typhoid poison has two separate modes of existence; one within the infected body, which constitutes the soil wherein it breeds and multiplies, and the other in media external to the body.

In its external phase the poison is exposed to a great variety of conditions, which, whether in the way of hindrance or promotion, materially affect the work of fever-propagation.

The more important of these conditions we must now proceed to consider.

The Full Contagious Power of the Intestinal Discharges Not Developed at First—Various Theories to Account for the Fact

In the 'British Medical Journal' for March the 16th, 1867, in the course of an abstract of a clinical lecture, by Dr. Murchison, on the eliminative plan of treatment in typhoid fever, there occurs the following very remarkable statement.[24]

> 'The advocates of the eliminative plan of treatment ground their views on the assumption that the peculiar poison which gives rise to typhoid fever is contained in the evacuations; but Dr. Murchison maintains that there is no proof, whatever, that the fresh stools

> passed by a typhoid patient are in any way deleterious. It is very probable, it is true, that the fever is propagated by the stools, but only after they have undergone decomposition. He rests his position on the fact, that, during the last five years, cases of enteric fever and cases which have not been fever at all, have been treated in the same wards of the London Fever Hospital, that 1,739 cases of the former and 2,123 of the latter have been interspersed together, and yet that not one of the patients in these wards has contracted enteric fever, although all the circumstances were most favourable to the propagation of the disease by the stools.
>
> 'Night-chairs are placed between the beds, which are often indiscriminately used by the patients on each side; the pans are emptied only once a day, and no means are taken for disinfecting the stools (a practice, I may parenthetically interpose, more honoured in the breach than the observance).
>
> 'The attendants in these wards have enjoyed a like immunity.'

Observations to the same effect have been made by many other physicians.

Although I could give very cogent reasons for not accepting the dictum, that the intestinal discharges of typhoid fever are not in any way deleterious when first voided, nothing is better ascertained than that, with common cleanliness, they are not very dangerous to the inmates of the sick-room.

As it is equally sure, and for proof we need not go beyond these pages, that this fever is mainly, if not wholly, propagated by them, it is clear that they must, after leaving the body, acquire in some way or other, a development of infective power.

The explanation of this seeming paradox has been made, in Germany, especially, the subject of many speculations, more fanciful than sound.

Conspicuous among the theories which have been invented to account for the phenomena, is that which is associated with the name of Pettenkofer.

This theory is couched by its author in terms so vague and mysterious that I never myself feel quite sure of exactly understanding what it involves.

His fundamental position, however, appears to be this:

That the poison of typhoid fever is not, like the poison of small-pox and the other contagious fevers, cast forth from the body in a finished state; that, in direct opposition, as regards this, to the other contagious poisons, it has, when first discharged, no power to propagate the fever at all, but can only acquire this power by going through putrefactive decomposition first.[25]

In later developments of the theory it is made to appear that the *soil* is an essential factor in the result—that in virtue of some mysterious reaction between the typhoid excreta and the soil, there springs up a 'tertium quid'[26] different from either, and which constitutes the real agent by which the fever is propagated.

Now, if by this, it be meant that the typhoid excreta acquire media external to the body powers of new nature and birth, and not inherent in them from the first; yet more, if it be meant that these powers are the offspring of a state of decay or putrefaction in the contagious germ itself; or, yet again (to illustrate the point in another way), if it be held under this theory that anything happens here essentially different from what happens in the case of the other contagions, the view is one from which I venture altogether to dissent.

Such a view is, as it appears to me, at once gratuitous and unnecessary, at complete variance with analogy, and unsupported by fact.

Exactly as in small-pox, so in typhoid fever, the contagious agent which issues in the specific excreta is the fruit of its own prior reproduction within the already infected body.

To carry on the line of succession a step farther, all that is needed is in either case, that this agent should retain in its transmission to the next recipient the reproductive powers of which it is, itself, the offspring.

That these powers may be quickened, after the discharges leave the body, in ways hereafter to be discussed, seems not improbable. But that anything beyond this occurs there is, I believe, no reason to suppose.

I am the more confident in the soundness of this conclusion, because other conditions hitherto, for the most part, entirely overlooked, may be shown, of necessity, to intervene, which go far to explain, even if they do not altogether explain, the apparent enigma.

The practice of inoculation has proved by experiment that the contagious unit necessary to the propagation of a contagious fever is a thing of extreme minuteness. But common observation puts the same truth in perhaps a still stronger light.

Of such impalpable minuteness, indeed, is the contagious germ that its reception into the body, when these fevers are taken in the natural way, is an act that is cognisable to no sense. Unless in the very rarest instances, in typhoid fever the disease we are considering—the victim never knows the moment of his infection.

To inhale, for an instant, the exhalations of a sewer; to walk down an infected lane or alley, where there may even be no offensive smell to warn the visitor of his danger; to drink a drought of water which perhaps may only differ, to the sense, from any other drinking water, in being more sparkling, or in having a brisker smack, is often to be stricken with this fever unto death.

But if, in the act of implanting the disease, the poison is impalpable, its condition on issuing from the body, is the very opposite of this. Although in its final dispersion it is resolved into mere molecules, it is first cast off in bulk.

Much of it, even when first voided, is, no doubt, already in a state of fine division, but much, also, is present in the form of clots or pellets of yellow matter, which are to the contagious germs which float impalpable in air or water, much as the block of granite is to the dust into which it may be ground.[27]

The application of these considerations to the case before us must be obvious to everyone.

If they be true, it necessarily follows that, before the poison contained in the typhoid stool can exert, to its full extent, the contagious power inherent in it, and take its full part in the work of typhoid propagation, it must be liberated, by drying, fermentation, or some other mode of disintegration, from the clots, pellets, or other organic husk or entanglement, in which it is embedded, and resolved into particles, which, suspended in the media that surround us, represent the condition under which it can alone convey widespread infection.[28]

The case may be likened to that of the poppy or many another plant.

Poppies, like contagious fevers, propagate themselves. When the seed-capsule is ripe it drops off, but the capsule itself has to be broken up—often traveling long distances the while before the numberless seeds it encloses are cast out upon the soil to spring up as fresh poppies.

And so, in a measure, with the fever-seed also.[29]

It will be seen, further, that these considerations apply, more or less, whatever the medium through which the contagion passes from one subject to another. Less absolutely, however, to transmission by water than to transmission by air.

For, as the discharges are fluid, the poison they contain is more or less diffusible in water from the first.

But, in transmission by air, before this poison can take part, at all, in the work of propagation, it must not only be resolved into the molecular state, but the infective molecules must have escaped from the liquid medium, in which they were first eliminated, into the air we breathe.

When it is added that, in spite of all that has been said and written to the contrary of late, there is reason to believe that air is the chief vehicle of this infection, the importance of this principle, in its application to the dissemination of typhoid fever, is at once understood.

In water infection the succession of events is more rapid, and as a rule the resulting disease is more fatal; infection by air, although more slow, operates on a wider scale, and in the aggregate affects a still larger number of persons.

Thus it is, that without having recourse to hypothesis at all, and confining ourselves within the limits of conditions which are known to operate, we see why the intestinal discharges must, of necessity, become, in course of time, incomparably more effective in spreading the fever than when first cast off.

It is not that any new powers are called into being, but only that the powers, already existing, are brought into play. In proportion as the surrounding conditions further or prevent the changes necessary to this, on the one hand, and in proportion as they lay open, or shut up, ways for the transmission to other subjects, of the liberated infectious swarm, on the other, in the same proportion do these conditions hinder or promote the spread of the fever.

Subject, possibly, to a qualification hereafter to be mentioned, it is in this way, and in this way alone, as I believe, that external physical agencies operate.

This is particularly true of the important agencies of soil and water, about which, with some few points of real interest, so much that is questionable has been written and said.

In following out these same relations we may see the real explanation of the part which fermentation or putrefaction takes in the process.

I have already expressed my opinion that fermentation does not act, at all, by communicating any new property to the essential agent.

It creates no new power or gift.

But, as the great instrument of the softening and disintegration of organic matters, it probably has the principal hand in hastening the extrication and liberation of the germs in which the infective power resides.

It is even probable that the gases which are so abundantly evolved, in result of this process, and which often rise into the air with considerable mechanical force, still further help, by carrying these germs with them, the atmospheric diffusion of the contagious matter.

By the light of these considerations the very striking facts related at the beginning of this chapter on the authority of Dr. Murchison lose all their apparent mystery. No facts in the history of this fever have more perplexed observers, have given rise to so much groundless speculation, or have proved so great an obstacle to the reception of the doctrine of contagion.

Does the explanation here, offered of them apply to all cases? Does it cover the whole field? Are there any outlying phenomena which do not fall within it? Various considerations have led me to think that it may be worth inquiring whether exposure to the open air, and specially to the oxygen it contains, may not give increased energy to the contagious agent.

Dr. Calvert has lately made the important observation that infusoria multiply much more rapidly in oxygen than in common atmospheric air.

As oxygen is the great quickener of all vital power, this increased fertility is a result that is intelligible enough.

But this multiplication of the living organism is something so near akin to the multiplication of the contagious agent, that it would not be surprising if this also were affected in a similar way by similar exposure.

Although, however such considerations as these may be interesting as suggesting inquiry they must not be considered, at present, as having gone beyond the speculative stage, or as standing at all in the same category with what has been laid down before as regards the atmospheric dispersion of the contagious particles.

Other doctrines have been put forward which may be dealt with more summarily. Such, for instance, is the doctrine which some hold, that the specific poison of typhoid fever, multiplied as it is known to be within the living body, in virtue of the fever process itself, continues to multiply after its exit from the body, in the media into which it passes.

There is, in reality, no plea whatever for this assumption.

On pathological grounds there are the strongest reasons for believing that as in small-pox, so in typhoid fever, the specific poison is only reproduced in the living body infected with it.

The same general reply may be made to another hypothesis, which, on abstract grounds, is not otherwise untenable.

Many examples are now known of very noxious things which propagate themselves by multiplying within the living body, but which cast off germs totally incapable of carrying on the succession until they have passed through another phase, in media external to the body. Whether these media be the living bodies of other creatures, or not, makes no difference.

The case of the tapeworm is a familiar instance. It is well known that the ova of this parasite, after being shed by man, have to pass through an intermediate form in the body of the pig or some other domestic animal, before they can again produce the tapeworm in the human subject. It has often occurred to me to ask whether something of what is [a, Ed.] matter of actual demonstration as regards the palpable entozoon, may not happen in regard to the impalpable entities which cause contagious diseases.

That some of these will be eventually found to come under this description seems not improbable.

But that the material cause of typhoid fever should be counted among them there is no reason to believe.

Before leaving this part of my subject, there are one or two minor questions, of some importance, on which it may be well to say a word.

Typhoid fever is a contagious fever propagated by a specific poison.

How long after its discharge from the body does this poison retain its contagious power?

Unhappily, there are no data which enable us to give an exact answer to this question, and, for obvious reasons, such data must be very hard to get.

If, in default of these, it may be permitted to draw from analogy, we come to a very decided conclusion. There is a growing belief that the specific germs which cause contagious fevers are, in reality, so many living species.

Now it is a well-known fact that, under certain conditions, infusoria and other minute organisms may retain their reproductive powers in a dormant state for indefinite periods of time.

There is abundant evidence to show that the same thing holds good of the specific properties of many of the contagions. Vaccine, when protected from air, or when in the dried state, keeps good for a long time.

It has been all but proved that articles of dress tainted with the poison of scarlet fever retain the power of communicating that disease for years.

Many facts have come under the notice of observers which seem to show that the poison of typhoid fever offers no exception to the rule.

I once knew a labourer's cottage which remained vacant nearly two years, in consequence of nearly every inmate of it having contracted typhoid fever. At the end of that time it was re-tenanted, and three weeks had scarcely elapsed before several of the new inmates were simultaneously seized with the same fever. The cottage stood alone in a secluded spot, and there was no fever in the neighbourhood at the time of the second outbreak.

Some years ago there was a very heavy epidemic of typhoid fever in the parish of Lapford, in North Devon. One farm, in particular, suffered terribly, as many as seven of the farmer's family having taken the infection. At that time the farmer's wife escaped the fever. But, about fifteen months afterwards, when the disease had long disappeared from Lapford, she was seized with it, and narrowly escaped with life. She had not left the place for a day since the former outbreak.

In his work on 'The Practice of Medicine,' Trousseau relates a similar case, in which the second attack occurred at the end of a year, and adds the curious remark that, in his experience, the fever has shown great proneness to return in the same house at the twelvemonth's end.

Under what guise the dormant poison lurks in such cases it would not be easy to say.

But in seeking to interpret the conditions under which this species of fever breaks out, facts and considerations of this order must not be lost sight of.

The Cesspool and the Sewer

As the great bulk of the typhoid poison, from the form in which it is cast off, necessarily finds its way to the soil, the nature of the conditions it meets with there must affect in an important way its distribution.

I should have much to say on the effect of these conditions had I time for the task.

As, however, the object of this work is mainly practical, and, by bringing to light, the cause of typhoid fever, to teach us how to destroy it; in other words, as its principal aim is, as far as this fever is concerned, to render us independent of soil and everything else, my treatment of this branch of the subject will be purposely brief.

In the study of it, two principal cases have to be distinguished: the cesspool and the sewer.

It is in the first that variations in soil chiefly come into play.

The nature and constitution of the soil itself, its degree of porosity, its elevation, slope, line of watershed, greater or less saturation with air and water, its temperature, and many other conditions that might be named, all affect more or less the power and distribution of the poison.

On many of these points, Hirsch, Pettenkofer, and, more recently, Dr. Haviland, have made observations which, although they must not be taken in too absolute a sense, are not without interest.

Those who desire further information on these topics I must refer to the writings of these observers.

As regards the sewer, the error commonly committed is to look at it too much in the abstract. By most people it is conceived of, simply, as an artificial and more or less perfectly closed channel, in which human and other excreta, in a state of decomposition, and extricating foul gases, are carried away from the inhabited area.

Any one who has read Parent Duchatelet's remarkable book on the sewers of Paris, will see that this is a very imperfect idea of the great diversity of conditions the sewer presents.

The greater or less degree of incline, the amount of water carried and the rapidity of its flow, the variations of temperature in accordance with variations in climate or season, or depth below the surface, the manner in which its temperature is influenced by frost, and especially by the sudden melting of large masses of snow or ice, the existence, sometimes in fixed directions, of strong aerial currents, are all elements that must not be lost sight of.

Another element remains which, as far as I have seen, has hitherto been entirely overlooked, but which there is reason to believe may become a very important factor in the case. I speak of the admixture with the sewage proper, of various strong chemicals, often in very large quantities, under the form of manufacturing refuse. Some of these chemicals are known to have strong disinfecting powers, and it has often occurred to me that it would be very interesting to inquire whether the hitherto unexplained immunity from cholera, for instance, of some great manufacturing towns, may not be in some degree due to the disinfecting action of these products.

Media of Transmission—
Tainted Hands—
Tainted Linen, Bedding, and Clothes

In the cases related in previous chapters in illustration of the contagious nature of typhoid fever various modes of communication have already, incidentally, come into view.

The part they severally play in the dissemination of the disease must now be examined more closely.

One mode of communication has attracted little attention, which it is important, nevertheless, not to overlook; I speak of the tainted hands of those who wait on the sick. Among the poor, and in ways that will suggest themselves, and need not be more particularly described, there is reason to believe that this mode often has a large share in spreading the disease through the family circle. Passing from the hand to other things under contingencies that are not only very conceivable, but are sure now and then to occur, the contagion thus arising may sometimes have a much wider scope. I possess evidence which renders it in the highest degree probable, that milk and butter, especially, may become infected in this way.

Linen, wearing apparel, bedding, and other porous fabrics, tainted with fever, constitute another important form of vehicle.

In 1867 there was a very severe epidemic of typhoid fever in one or two small villages in the neighbourhood of Berkeley, and, among others, several members of a clergyman's family were laid up with it.

A young woman who lived in a hamlet more than two miles away, but who washed the tainted linen of these patients, caught the fever, which afterwards attacked two other sisters living under the same roof with her.

Examples of infection by tainted linen or clothing are not very common now, for the obvious reason that people generally have learnt the vital importance of disinfecting such things before sending them to the wash. But before this precaution had come into vogue, nothing was more common than to see washerwomen and their families stricken with typhoid fever in consequence of having washed the bed and body linen of patients suffering from it. Some of the most painful tragedies I have ever seen have originated thus.

In a paper published rather more than thirty years ago, Dr. Tweedie stated that the washerwomen to the London Fever Hospital so infallibly took fever that it was difficult to get women to undertake that loathsome office.

Although this statement probably applied more particularly to *typhus*, there is reason to believe that it included the case of *typhoid* also.

In other instances the pawnbroker is the victim.

In a report by the late Dr. J. Clark on fever in Newcastle there occurs the following passage:—

> 'In a neighbourhood where a fever subsists, some person, belonging perhaps to the family of a labourer or mechanic, from motives of humanity visits and assists the sick. In consequence of this infection is caught. The husband, after the disease is introduced, is often infected from attending the wife; and if the family have but one apartment, few escape the contagion. Poverty now presses hard on such a family, and if they have any stock of clothes or linen, they are gradually sold or pawned for their immediate support, and the unfortunate family, though in comfortable circumstances previous to the attack of this calamity, is soon reduced to a level with those in great indigence.
>
> 'But the evil does not terminate here. The clothes and linen, *especially of those who die*, are impregnated with contagion as well as the room, and servants who visit their friends or acquaintances during the fever, and more particularly those who buy articles of linen or apparel from pawnbrokers, introduce the infection without suspicion into the families of the affluent. Such unsuspected modes of introducing contagion can seldom be traced, but that they frequently operate powerfully cannot be doubted.'

Dr. Clark adds, by way of illustration, that the most malignant cases of fever he ever attended in Newcastle were in the families of three pawnbrokers.

Whether these were cases of typhus or typhoid, there is no means, now, of knowing. But, in the course of a long experience, many instances have come to my knowledge in which the receipt of a parcel of typhoid-tainted linen has become the means of imparting the fever to its new possessors.

It is no doubt chiefly in virtue of a taint communicated to the *clothes* that nurses and other persons in attendance on the sick acquire, sometimes, the power of communicating the disease to others, although not themselves infected.

Piedvache and some other writers have attempted to throw discredit on this mode of communication, but I have seen too many instances of it to doubt its reality.

When I was in practice at North Tawton, I attended the wife of a butcher there, in a severe attack of typhoid fever.

There was no fever at North Tawton at that time; but a short time before this woman was attacked, her mother, who lived with her, had returned from a small lone cottage, six miles off, where she had been engaged for several weeks in nursing a whole family laid up with typhoid.

In December, 1867, two young ladies, living in country houses about two miles apart, having been invited to a ball, were measured for new dresses, on the same day, by the same dressmaker, who went for this purpose from one of these houses to the other, staying a considerable time at each. In the course of a fortnight both sickened for [*sic*] typhoid, and in both the attack proved to be very severe. They had not been away from home for several weeks before, and there was no fever in the immediate neighbourhood. But at the time when they were measured, the dressmaker, herself, had been nursing a child of her own, for several weeks, in a very bad attack of typhoid fever. For a fortnight or more this woman had passed a great part of every day with her sick child on her lap, and, as there was severe diarrhoea, it is more than probable that her clothes had become more or less soiled with the specific excreta. As I was consulted in one of these cases, and heard from the medical man in attendance all the particulars of the illness of the dressmaker's child, I can, as far as these two are concerned, vouch for the facts.

I have brought forward these illustrations of the conveyance of typhoid fever by infected clothing—and I could add largely to their number—not only because this particular mode of infection has been allowed of late years to drop entirely out of sight, but because it at once strips from the contagion of this particular species of fever numerous fantastic notions, which, without a shred of scientific evidence to support them, have been suffered to gather round it.

The minute and impalpable agent which gave the fever in the cases just referred to, had had no commerce with drains, and was perfectly innocent of sewer gas. It had entirely escaped that mysterious concoction which is supposed to occur only in the drain, and which is held to be essential to the production of this particular type of contagion.

It had had no contact with the soil or with drinking water.

Cast off, in each case, by an already infected subject, and caught and retained by the woven fabrics in use about the sick, it gave the fever to the next sufferers, just in the same way in which the small-pox virus carried in the tainted clothes of a small-pox nurse has been known in numberless instances to give small-pox.

It is the act of infection stripped of all extraneous and adventitious conditions, and shown in its naked simplicity.

Between the reproduction of the fever poison in the intimate recesses of the already infected body, by the action of the fever process, and its effective implantation in the bodies of the next sufferers, a few fibers of cotton or of wool were, in many instances, all that intervened.

In the small-pox and in the fever the two facts are of exactly the same order. Much stress has, no doubt, been laid upon the inoculability of the one and the failure of all attempts, *hitherto made,* to inoculate the other. By some this has even been considered warrant sufficient to place these two self-propagating fevers in two distinct categories. As if the mode of implantation of the infecting germ made an essential difference.

It would be just as rational to argue that two kinds of seed cannot both be of the nature of seed, because one has to be planted by dibbling, while the other may be sown broadcast.

That the germinal unit, no matter how implanted, which is the offspring of a former crop, should be capable of producing another crop like it, that, and that alone, is the essence of the matter.

Of the efficacy of infected beds as agents for the propagation of this fever I shall speak in a future page. It will be sufficient here to observe that in the course of my experience I have seen many decisive examples of it. In connection with this part of my subject I may state that two cases have come under my own observation which have made a great impression on my mind, as showing how unconsciously, in the ordinary course of life, we may become exposed to some of the sources of contagion here passed in review.

Many years ago I attended, in consultation with another practitioner, the landlord of a large hotel, who was suffering from a fatal attack of typhoid fever. During his illness he lay, at first, in a room looking into a street in which there was much noise and incessant traffic. Towards the latter end of the third week he became violently delirious, and as the noise appeared to excite him, he was moved into a back room. I had gone to the front room so often that on my visit the next day mechanically, so to speak, I went there again. What was my horror, when, on opening the door, I saw a strange gentleman there just beginning to dress. Arriving the night before, he had been placed in the very same bed which the fever-patient had vacated in the morning.

This frightful step had been taken more in ignorance than anything else. The hotel people had been assured that the fever was not in any way contagious, but the result of bad drainage only, and so they supposed that they had exposed their guest to no sort of risk.

Some years later, I was consulted in a case in which a large proportion of the inmates of another hotel had been successively stricken down with typhoid. The fact had been kept strictly secret from the visitors, and no steps whatever had been taken to repair the drainage, which was in very bad order, or to disinfect the typhoid discharges.

On my expostulating on account of the possible consequences of such neglect in a house which strangers were constantly passing through, the answer made to me was, that to be using disinfectants, or to be pulling about the drains, would most probably betray the presence of the fever, and that to betray the presence of the fever would be to half ruin the business!

Truly, this is, in its very inmost soul, a commercial age.

Whether any of the persons exposed to infection, in these two cases, took the fever or not I cannot say; but supposing some of them to have done so, it is easy to see how perplexed they might have been to trace their illness to its source, and with what plausibility the fever thus arising might be set down to spontaneous origin.

Media of Transmission Continued— Air and Drinking-Water

Of the part which tainted hands, linen, bedding, and wearing apparel, take in the propagation of this fever, sufficient has already been said.

The proportion of cases that originate in these sources is, no doubt, comparatively small, but unless they are kept in view, many incidents in the general history of this fever will remain unexplained.

But the propagation of typhoid fever on a large scale, and down through the ages, is effected through other media.

We have already seen that the bulk of the poison by which the succession is kept up, is cast off by the intestine in a liquid form. The first effect is, therefore, as I have before said, to infect the ground.

Obviously, there are two *principal* ways, and two only, in which a poison cast out upon the ground can find its way back again into the living organism. Either through the drinking-water, or by emanations borne upon the air.

The outbreaks of typhoid fever at Richmond Terrace, Clifton; at Cowbridge, in Wales—and many others equally striking might be added to these—show better than any general statement, what a potent means of propagation infected drinking-water may become.

In order to have a just estimate of the share it takes in the propagation of this fever, we must include the cases in which fever-tainted water is drunk as a diluent of milk.

How widespread and fatal the infection from this source may become is strikingly illustrated by the memorable outbreak of fever in Islington, related by Dr. Ballard some two or three years ago, and which that gentleman traced with admirable skill to the use of milk supplied from a dairy where typhoid fever was at the same time prevailing.

Two very important instances of the same kind have lately come under my own observation, and I have no doubt that this mode of infection is much more common than it is generally supposed to be.

The following very graphic narrative, which, under the head of 'A Milk Walk,' appeared in the 'Bristol Times' for June the 30th 1855, will show how completely, in this vital matter, the people who have the misfortune to live in towns are at the mercy of men of the very lowest class:—

> 'In one of those flat outlying districts of Bristol, where moist meadows, dry cinder-heaps, tall smoky chimneys, and the oozy bed of a flat low-lying river contend for the mastery in the landscape—I, a few mornings since, found myself. Unpromising as was the scenery, my walk nevertheless led me through a pleasant green field, on which a number of cows were grazing, and where some milkmen were already filling their cans. Along the edge of the meadow a stream ran, not the most pellucid in the world, and a short lane led thence out into the road, which was skirted by the dwellings of those whom I would best designate by the title of the humbler of the middle class. Having often heard the popular opinion as to the questionable quality of the article sold to whiten our morning Souchong,[30] I indignantly exclaimed to myself, as I saw one milkman shoulder his cans and start on his journey, "Now, surely, that milk can't but be genuine." I was a little too soon, however. The owner of the cans went not quite straight to the short lane aforesaid, but deviated on his way to the unpellucid brook. Uncovering his two cans at its edge, he caused one thereof to hang over the water, and the other the land, and then gently stooped his respectable person, until one vessel rested on the earth, and the other received over its edge a bountiful supply of the running stream.
>
> 'When he had apparently satisfied himself with this process, he placed both his vessels on the earth, poured some of the contents of one into the other, then back again—in fact, he brewed the beverage.
>
> 'Shouldering his cans then, and passing up the short lane and out into the street, he cried out—
>
> ' "MILK!" '

This sketch is the more important because, when he wrote it, Mr. Leech, whose lively and facile pen the readers of the 'Bristol Times' will at once recognise, had clearly no sanitary after-thought in his mind. The only plea he offers for its insertion in his journal is that what it describes is actual fact.[31]

The extreme gravity of the incident may be conceived when I add that in the course of little more than a mile above the point where this reckless, but, it is to be feared, too typical, milkman[32] replenished his cans, the unpellucid stream, which supplied the water, received a large proportion of the sewage of the village of Stapleton, and the entire sewage of the workhouses of Fishponds and of Stapleton establishments counting, between them, some twelve hundred inmates, *and two large infirmaries!*[33]

Large, various, and terrible are the possibilities here.

In ordinary times the addition to milk of water even thus polluted might, it is true, lead to no very immediate or flagrant consequences to the public heath; but when, as must often happen under such conditions, the pollution largely consists of the excrete of infectious diarrhoeal disease, the use of milk so watered must be full of danger to those who drink it.

One point to be particularly noted in connection with the propagation of fever by milk diluted with infected water is that, in towns especially, the real source of the disease is generally quite unsuspected, and the events take a form that seems to baffle speculation.

Many cases of so-called spontaneous origin have, no doubt, sprung up in this way. From the prominence which a few signal instances of it have given to the agency of drinking-water in propagating this form of fever, some writers have jumped to the conclusion that this medium is the only vehicle of the fever poison.

This, as we shall see, is a great mistake.

It will be sufficient to cite one or two instances in proof.

Take, as an example, the outbreak—at Chaff comb (described in a former chapter). At the farm there, which suffered so severely that nearly every inmate was attacked, the drinking-water was beyond the reach of possible contamination.

In the third report of the Medical Officer of the Privy Council, an epidemic of typhoid fever is described[34] which occurred at Kingston Deverill, in Wilts, in 1859. At the date of the report, out of a population of about 400, 66 had already been attacked, and six deaths had occurred.

A like portion of attacks and deaths occurring in London, estimating its population in round numbers at 3,000,000, would give to typhoid fever alone nearly 500,000 attacks and more than 45,000 deaths. A truly enormous proportion.

Now, in this terrible outbreak, the drinking-water, which came from deep wells in the chalk, was not only bright and clear, but was reported by the Government officer 'to be beyond even the suspicion of foulness.'

The same relations were observed at Festiniog in Wales, in 1863. The exact number of cases of fever could not be ascertained, but among a population of six or seven thousand, in the affected districts, it was computed that there had been not fewer than six or seven hundred cases of fever. In the villages of Bethania, Tanygrision, and Glanypool, scarcely a house escaped, and in many five or six persons were attacked in a single house; and yet, with the exception of Bethania, the drinking-water for these villages was got from wells in the mountain, 'presumably situate [*sic*] beyond any possible source of pollution.'

But if it be suggested that, in these examples, the typhoid infection might, after all, have got into the water in some subtle and unsuspected way, the three yet to be related shut up the last opening to such a view.

Of these three, two—namely, an outbreak of typhoid fever in a convent at Arno's Court, near Bristol, and an epidemic which occurred some years ago in the parish of St. James, Bristol—have already been cited by Dr. Tyndall in his interesting and deeply suggestive paper on 'Dust and Disease.' The history of the outbreak at Arno's Court will be given, at length, in the next chapter. It will be sufficient for my present purpose to say that the establishment, which was the scene of it, was supplied by water from wells beyond the reach of sewage contamination, and to mention the following additional facts as proofs that this water had no hand in spreading the fever.

1st. The water was proved, by examination of the well and by accurate chemical analysis, to be entirely free from sewage.

2nd. The fever was confined to one division of the inmates. Another large division, drinking the same water with the first, escaped; or, in other words, those who were decimated by fever drank the same water with those who had no fever at all.[35]

3rd. From the very time when disinfection was brought to bear on the typhoid excreta, the fever began to cease, although the same water was drunk as before.

Lastly, since the outbreak nothing has been done to the well—the water remains what it was; but, with the exception of one or two imported cases, which have been dealt with by disinfectants, fever has not recurred in the establishment.

The evidence furnished by the Bristol epidemic is to the same effect. In the course of an hour, Dr. Pring, who, as Poor Law Medical Officer, had charge of the sick, and who, a few weeks later, died of typhoid fever contracted in his attendance on them, showed me more than eighty cases, within a small area, in the parish of St. James.

Now, Bristol is supplied with drinking-water which from its source in the country to the tap from which it is delivered under high pressure to the consumer, flows through conduits out of all reach of sewage contamination.

But, with the exception of a single household, all the fever patients under Dr. Pring's care were drinking this water—the very same water which, as far as fever is concerned, more than 150,000 of their fellow-citizens, outside the infected area, were drinking with absolute impunity.

The last example brings us back, once more, to the town of North Tawton, from which, among the incidents of a great epidemic which occurred there in 1839, our first illustrations of the contagious nature of typhoid fever were drawn.

About two years ago, after an interval of thirty years' almost entire immunity, this town was again visited by typhoid fever.

Meanwhile, a water company had been established, by which drinking-water brought from a considerable distance, in iron pipes, is delivered under high pressure to every inhabitant. Contamination of this water by human excreta is an absolute impossibility. And yet in this second outbreak of typhoid the population suffered even more severely than before. In the course of a few months, out of a population of 1500 persons, 120 were known to have had typhoid fever, and eleven of their number died.

In conclusion, I will only observe that, if water be excluded, the air is, as I remarked at the outset, the only other possible vehicle by which a poison generated in the living body can find its way back to the interior of other living bodies, on a scale sufficiently large to cause the resulting disease to assume an epidemic form.

In the three terrible epidemics of Arno's Court, of St. James, Bristol, and of North Tawton, at least, the air was the great medium through which the infection passed.

But if so, it is further obvious that in these cases this was not the work of chance, or accident, but only represented *the effect of agencies which are always in operation where this fever is prevailing*.

The phenomenon is, in fact, merely the expression of a general law.

The contagious particles cast off, in the liquid excreta of contagious diseases, rise into the air by no power of their own, but in virtue of conditions which cause the germs of the great tribe of Infusoria—organisms which, as their name bespeaks, breed in liquids—to rise in swarms into the atmosphere.

At some future time, I hope to show that the same law covers, by the same physical necessity, many other specific morbid products not hitherto classed among contagions at all. So wide, indeed, is its operation, that it includes not only a whole kingdom of nature, but the most populous of all, whose countless species are propagated down, through time and space, by this mode of aerial dissemination.

I have been the more anxious to bring forward these facts and considerations, not only on account of the great practical importance of the question to which they refer, but because the most erroneous doctrines have recently been put forward upon it, under the sanction of very high authority.

About three years ago, it was laid down by a very distinguished physician as an established principle, that it is impossible for typhoid fever to spread widely in any community provided with pure drinking-water. With the cases just related before us, I need scarcely say that this assertion is entirely at variance with fact.

In the same degree it is dangerous, as tending to divert attention from the one safeguard by which, alone, the spread of typhoid fever can with certainty be presented—viz., the disinfection of the typhoid excreta immediately on their issue from the body.

Drinking-water, whether mixed or unmixed with other things, is a frequent and a very deadly vehicle of the typhoid poison. That its condition should always be looked to is of the first importance in fever outbreaks, and, where there is any suspicion of impurity, even, it should be provided against. But whoever trusts to the purity of this element alone, as a certain guarantee against the spread of the fever, will often find, to his cost, that he made himself responsible for grievous calamities.

The exact proportion which the cases caused by infected water bear to those caused by infected air is not easy to determine, and probably varies much under different conditions of soil, climate, season, water supply, social habits, and sanitary arrangements.

As far as my own experience goes, I can state that the worst and most wide-spread outbreaks which I have ever witnessed have occurred in communities where the drinking-water was absolutely blameless.

The one great aim to keep before us should be, by timely and effective disinfection, to prevent both air and water from becoming infected.

Typhoid Fever— What Period Beginning, and at What Period Ceasing, to Be Contagious

One or two supplementary questions yet remain to be examined before we can obtain a complete view of the modes in which typhoid fever is disseminated.

At what precise period does the fever first become contagious, and when does it cease to be so?

To the first question a tolerably precise answer may be given.

Putting pathological probability aside, facts have repeatedly come before me which appear to show, by evidence free from all ambiguity, that the contagion begins with the diarrhoea. Or rather it would be more exact to say—for the evidence does not go beyond that—that, when diarrhoea is present, the disease is, certainly, already contagious. As this symptom often begins a considerable time before the patient takes to his bed, and while he is still up and about, it is easy to see what an important influence the fact may have in spreading the disorder. Persons in this stage, going about from place to place, may obviously lay a train of wide-spread infection.

But it is in schools, workhouses, and other large establishments, where a common latrine often serves for a large number of persons, that this contingency tells most. Since I came to Bristol, I have seen three very considerable epidemics of typhoid, originating in the infection of the latrine of a particular day-school, by one of the scholars, who, having contracted fever and already affected with diarrhoea, still continued to attend the school for some time longer.

In my various writings on infection, I have repeatedly had occasion to draw attention to these relations in their bearing on the part which large establishments play in the spread of epidemics. This mode of spreading constitutes one of the greatest of all the difficulties in the way of prevention, and forms the ground of my proposal to make it compulsory to provide all such establishments with self-disinfecting latrines. Obviously, it is a difficulty that can only be completely met by what I have ventured, elsewhere, to call disinfection by anticipation.[36]

The precise date at which the fever patient ceases to give fever to others is not so easy to define. But I have seen so many instances in which fever has broken out in a family living in a previously healthy neighbourhood, soon after the arrival of a convalescent, that I am quite sure that patients, so far recovered, cannot always be safely allowed to mix with others without precaution.

In the cases referred to, all traces of actual fever had disappeared, and diarrhoea had long ceased.

In what form the infection still lurked—whether in articles of wearing apparel that had become tainted in an earlier stage of the fever, or whether in the form of specific exuvae from which the diseased intestine may not have entirely cleared itself, I confess myself unable to say.

The facts suggest two important precautions. The first is always to provide the convalescent with clothes perfectly free from specific taint; the other, to charge the cistern of the closet belonging to the house, in which he may be staying, with a powerful disinfectant.

For many years past, I have been in the habit of enforcing both, and, since I began to do so, I have never seen a convalescent give fever to a healthy person.

CHAPTER VI
Prevention-Disinfectants and Disinfection

'That Man, who is rapidly subduing all the most Titanic forces of the universe to his commonest uses, should always remain at the mercy of these ignoble things, is an antithesis too extreme to be permanent. The subjection of the powers of nature to our will has always seemed to me to imply, as a strictly correlative achievement, the putting the plagues of nature under our feet.'

In the course of this work, I have already had occasion to speak of disinfection as the one great means whereby the spread of typhoid fever may be prevented.

What are the agents to employ for this object? There is considerable diversity, both of opinion and practice, in the profession, as to this point.

As far as disinfecting power goes, a considerable variety might be named, which are equally effective. Although, when dry, the typhoid poison seems to be very tenacious of life—if I may so speak—there is reason to think that, in the moist state, it is very easily killed.

Among the chemicals which I have, myself, used, with equal success, for preventing the spread of typhoid, the following may be enumerated:—Chloride of lime, chloride of zinc, chlorine water, sulphate of iron, carbolic acid, and the two last-named agents mixed. I have not tried chloralum; but if what has been reported of its power in disinfecting the clothes and bedding of small-pox patients may be trusted, it ought to be equally efficacious.

Perchloride of iron is another substance which I believe to possess great disinfecting power, and which has not had the trial it deserves.

But chemicals are not the only agents by which contagion may be disarmed. It has been proved, by experiments conducted on a large scale, that a temperature of 212°—that, namely, of boiling water—entirely destroys the contagion of the small-pox, vaccine, and other poisons, even when in the dried state. Heat, therefore, is one of the most powerful of disinfectants.

Of these various agents, some are more convenient for one use, and some for another. For the disinfection of linen, chloride of lime in water is perhaps the most handy. Discredit has been of late years thrown on its disinfecting power, but entirely without reason. It was the only chemical used in the suppression of the Arno's Court outbreak, to be related in the latter part of this chapter, and I have used it with the same success in many other outbreaks almost equally formidable.

To make doubly sure, all tainted linen should be *boiled* as well as washed. Things not conveniently washable, such as mattresses, feather beds, pillows, or what not, should either be burnt or be raised to a temperature of 300° in a disinfecting oven. Of the various preventive measures this is the one which, in the houses of the poor, especially, is the most likely to be neglected. There is scarcely any measure which it is more important to execute. Mattresses, blankets, and feather beds—all things on which the sick lie—remain longer in close contact with sources of contagion than any other articles exposed to it. In the same proportion they are in risk of becoming more saturated with it. There is evidence to show that in typhoid fever the infective power thus acquired may continue effective for a long period of time.

On the other hand, these same articles, particularly in the lower strata of society, are frequently changing hands. Nothing in life has astonished me more than the recklessness with which, even respectable people, commit their persons to secondhand bedding, often without any preliminary purification, or a single thought as to what dangerous taint may possibly have been deposited in it by former possessors.

After the termination of every case of this fever, to annihilate by one or other of the methods just mentioned every trace of the fever poison, is one of the foremost and most pressing duties of the medical attendant.

For disinfecting the discharges, chloride of lime, chloride of zinc, carbolic acid, and sulphate of iron, or the two last mixed, may be equally relied on. As I said before, chloralum is probably equally good. For the strength of the necessary solutions and the quantities in which they should be employed, the labels attached to the vessels or packets in which most of these agents are retailed may be generally trusted.

I have, however, given in the appendix code of rules for the prevention of typhoid fever which I drew up for general circulation a few years ago—some instructions as to these points sufficient for practical use.

In carrying out this system of prevention, two great principles should be kept in view. The first is to be lavish in the use of the chemicals rather than to run the terrible risk of failing by default; the second, that whatever be done, should be done in that thorough and conscientious way which alone befits acts that may issue in health or disease, in life or death, to indefinite numbers of men.

My own practice is to place in the sick room, or close at hand, a large can filled with the mixed solution of carbolic acid and sulphate of iron, whose composition is given in the appendix; to keep the night-pan always charged with it, and after each use of the pan to pour upon the discharge a quantity of the solution sufficient to *insure* the disinfection of what has been voided.

In addition to this, and in order to provide against possible lapses on the part of attendants, I have often thought it well to keep the water closet, cistern permanently charged with the disinfectant in use, so long as fever may last in the house.

Where the social conditions of the patient admit, certain other aids ought to be found in the sick chamber which materially help in the work of prevention.

Free ventilation by fire in an open chimney, and by open window, also, if the season allow, and, if need be—the removal of carpets and of all needless draperies—the shifting of the sick bed away from the walls of the room, so that air may freely circulate round it—and (to provide for the immediate ablution of any taint the hands of the nurse may contract) two wash-basins, one containing clean water, the other water and chloride of lime—a little scouring sand, and an array of clean towels—such are the arrangements which make up the ideal towards which the physician should always aim.

These arrangements are not only good in themselves, but good, also, as so many pledges, that the people concerned are alive to the deeply responsible nature of the business they have in hand.

Another point that should never be overlooked relates to the drinking-water.

In the infected home, itself, two cases may occur. The patient may have caught the fever from his well having become infected by some other fever-stricken member of the community in which he lives, or, having got the fever elsewhere, he may become the means of infecting the well, himself.

In yet other cases, the area of danger is greatly widened, as where, for instance, a large number of persons are supplied with drinking-water from a common pump, town pump or other. The outbreaks of typhoid fever at Richmond Terrace, Clifton, and at Cowbridge, in Wales, related in a former chapter, offer striking examples in point.

In a very fatal epidemic of fever which occurred at Guildford a few years since, the general infection appears to have been traced, mainly, to the percolation of typhoid excreta into the tank of a water company.

But it is in country villages, where the cesspool and the well are so often found in dangerous proximity, that this mode of wide-spread infection is peculiarly apt to occur. Some months ago, a lady living at the head of a large village in the West of England, being much annoyed by stench from her house drains, consulted on the subject a retail chemist, who advised her to drench the drains, daily, with carbolic acid. Soon after this, the same lady returned to the shop, and asked, with ineffable *naiveté,* if she could not be supplied with a disinfectant devoid of smell—her reason being, that her operations with carbolic acid had not been carried on many days, before the drinking-water in her own and some neighbouring wells stank so badly of the acid as to be quite undrinkable.

Relations of the same kind, for the most part previously unsuspected, have been more than once disclosed to myself by the same agent.

Some fastidious people object to the sanitary employment of carbolic acid, on account of its powerful and not too agreeable odour. But the possession of this odour is, in reality, one of the strongest recommendations of this valuable chemical; for it gives us, as we see here, the ready means of detecting, by scientific proof, a sanitary defect beyond all others the gravest—a defect which otherwise might often remain unsuspected, or beyond our power to trace by any equally ready method.

With experience of this kind before me, I have long thought it wise, where the most absolute reliance cannot be placed on the purity of the drinking-water, to enjoin all communities, in any degree infected with typhoid fever, to boil their water before drinking it. It is grievous to have to say that it is not superfluous to apply the same precaution to milk also.

So much for the cases—happily the greater number—in which the nature of the fever is recognised from the first.

But no preventive scheme would be complete which did not provide against those in which the fever remains, for a longer or shorter time, undetected. I have already shown how the occurrence in school-children of that type of fever, which the French call *la fièvre typhoïde ambulante*, may become the means of spreading the disease widely through a school, and thence through a large community. On these and other grounds, I suggested some years ago that all schools should have their latrines provided with self-disinfecting apparatus.

On still stronger grounds, the same provision should be enforced upon hospitals, in many of which, cases of this, and other self-propagating diseases, are often congregated.

Not very long since, I went to a large hospital to see the postmortem examination of a man who had died in the third week of typhoid fever. The medical pupil who had charge of the operation, having removed the intestine from the abdominal cavity, tied the upper end to a water tap, and turned on the stream. Immediately there issued from the lower end of the gut, a flood of characteristic yellow matter, which at once passed, with whatever powers it may have had, intact, into the sewers of the city in which the hospital was situated. If what has been said in this work of the properties of this yellow stuff be true, it is tragic to think of the possibilities that may have sprung out of this act.

In the evidence which I had the honour to give before the Royal Sanitary Commission in December 1869, I ventured to urge upon the Commission the great importance of providing by law for the permanent disinfection of the sewers of all hospitals.[37]

In the course of the last session, while the Sanitary Act was passing through Parliament, I repeatedly endeavoured, by representations made in influential quarters, to get a clause to that effect inserted into it. Up to this time these representations have, however, remained unheeded.

To allow all the virulent things that find their way into a hospital drain free course through the sewers of a crowded community, is a practice which will be seen, ten years hence, to belong to the Clark ages of sanitary science.

In concluding, I may add that, if the various precautions recommended in it were universally practised, my own experience fully authorities the expectation that we should see an immediate large abatement in the mortality from typhoid fever, and that at no very distant time the disease would become a pathological rarity.

Whether the neglect of them should be visited by penalties, as in the case of the neglect of vaccination, is another matter. My own feeling is that, for a time at least, it will be best if the option of adopting them be left *in foro conscientioe*.[38] This much, however, may be unhesitatingly claimed, that no man can, with a clear conscience, knowingly omit them, who has mastered the evidence on which they are founded.

One thing, at least, may be said of them—they can do no harm. There is no question here, as in vaccination, of 'doing evil that good may come.' For, even should these precautions fail of their main object, they will, at least, help to abate evils of which all men complain.

Of the permanent sanitary works, by which the spread of typhoid fever may be hindered, this is not the place to speak. The business of designing and executing these works belongs not to the physician, but to the engineer. Their chief object is to prevent the drinking-water, as well as the air of the inhabited area, from becoming contaminated by human excreta. As regards the water, we know how this may be effected, and the question is one of expense only. But as regards the air, great improvements must be made in our systems of drainage to enable us safely to dispense with the disinfecting measures detailed in the present chapter.

Typhoid Fever Imported into a Convent—More Than Fifty Inmates Attacked—Suppression of the Outbreak by Disinfectants—Other Examples

On February the 29th 1864, I was summoned to the Convent of the Good Shepherd, at Arno's Court, near Bristol, to advise in a great emergency.

The place, which had for some years been the retreat of a Roman Catholic community, was originally the seat of a country gentleman, a friend of Horace Walpole. Built in the latter end of the last century, when the confectionery style of Gothic was in fashion, it was described in a characteristic letter from the fastidious owner of Strawberry Hill, as a model of elegance and taste.

As a dwelling-house it had some very sterling merits. The walls and floors were faithfully and solidly built, the interior was dry, the rooms were spacious and airy, and the aspect was good. Two deep wells, secure from any possibility of sewage contamination, furnished the house with an ample supply of drinking-water.

Soon after the property came into the possession of its present owners, the building was enlarged by the addition of a considerable block, which, joined to the old mansion, formed three sides of a quadrangle, of which a newly-built chapel made the fourth. At the same time, the entire drainage was remodeled, the old drains were abolished, and earthenware pipes laid in their place.

The structure when completed was divided into three principal segments. The community of Sisters, then 25 in number, lived in the old mansion; the next division was a reformatory for girls, of whom there were 126; the third was occupied by penitents, to the number of 34.

Except that each division was ministered to by the Sisters and the resident chaplain, the three were completely isolated, one from the other.

In all important respects the reformatory was well fitted for its objects. The day-rooms and dormitories were spacious and fairly well ventilated, and the sanitary arrangements were more than ordinarily good. In the reports of the Government Inspector the establishment had more than once been certified in words of strong praise, as belonging to the first class.

For several years after its first opening the mortality was very low and the sickness slight. It is, however, worthy of note that after a time consumption became in a marked degree prevalent, and, at the same time, strumous ophthalmia became so rife, as to suggest to the Sisters the idea that it must be spreading by contagion.

In March, 1863, diarrhoea appeared in the reformatory, and, in the course of two months, more than fifty of the girls were under medical treatment for it.

But, unless the ailments here named belong to the self-propagating class, up to the date of the events about to be recorded no one of the *recognised* infections had ever attacked the inmates.

For some months past the mortality had been low, and the health of the whole establishment exceptionally good. There had, at various times, in the two or three preceding years, been some trouble with the drains, but this had seemed to have passed away, and there were no bad smells about.

In regard to the present history it is specially important to note *that at no time, whether the drains were at their best or their worst, had typhoid fever ever appeared within the walls.*

But the time had now come when this longstanding immunity was to be broken by a great tragedy.

The magnitude of this tragedy may be estimated by the fact that, before it had come to a close, fifty-six persons had passed through the protracted miseries of this fever, and as many as eight had died of it.

The origin of this terrible outbreak was to the last degree clear. The disease was introduced into the convent in the preceding November, by a young girl who was admitted to the reformatory, *while actually labouring under it.*

In the summer of that year, this girl had left the convent for service in a Roman Catholic family living in a large town some twenty miles off.

'In November,' I quote now from a written account by one of the nuns, 'we were informed by her mistress that she was ill of a fever then prevalent there. We were requested to see about her removal. On the 17th our chaplain went to the place, ascertained from her medical man that she was fit to be removed, and that he considered there was not the slightest risk to the school in her returning here to be nursed.'

The fever was, in fact, 'typhoid' fever, a fever known to be caused by bad drainage only, and notoriously not, in any way, catching. Such, in strict accordance with the well-known stereotyped traditions, was the language held.

It would, perhaps, be unjust to fix upon an individual the responsibilities attaching to a doctrine, which, in flat contradiction though it be to long recorded facts, is, in this country, still all but universally held.

But to me, at least, the spectacle of these poor helpless women, so many of whom were to be brought into untold suffering, and not a few even to death, by this assertion, is unspeakably touching. How much longer will these dangerous delusions continue to prevail?

Unhappily, the ladies of the convent were only too confiding. Blindly trusting to the assurance, endorsed as it was by their own medical man also, that the disease was not contagious, the fever-stricken girl was admitted, 'the discharges were thrown down the infirmary cabinet, her clothes went with those of the other girls to the common wash-house, and were washed by the girls employed there. There was no idea of any precaution being necessary.'

I have already shown, at considerable length, why it happens that when (the drinking-water being pure) an outbreak of this fever is lit up in an isolated community by a single imported case, some considerable time necessarily elapses before the next crop begins to spring up. This was the case at Chaffcombe, at Loosebeare, at the farm near Cardiff, and indeed in all the cases of the same kind related in this volume. For the same reasons, the same rule applies, 'mutatis mutandis,' to all the other contagious fevers.

So it was not until January 4th, as near as may be six weeks after the admission of the first fever case, that a girl, an inmate of the reformatory of some standing, after a week's drooping, was laid up with the same fever.

This girl, who was seventeen years old, had visited the fever patient in the infirmary and was also employed in the wash-house.

To put all question aside as to the specific identity of the fever itself, I may state that in one of the fatal cases I made a *post-mortem* examination and found the typical ulcerations and other changes in the intestinal follicles which are characteristic of this species of fever.

But even without this evidence, the following extracts from a written account by one of the nuns of this girl's case, would have sufficed to settle the point:—

'About February 1, less well. Diarrhoea (which before had not been violent) increased. The tongue quite purple. On the fifth it was found that there had been considerable hemorrhage from the bowels for five or six days, which she had concealed. Deafness came on about the middle of February. Diarrhoea ceased about March 5; at the same time phlegmasia dolens came on in the left leg.' Incidents, equally characteristic, occurred in all the other sufferers.

The dates of the succeeding cases were as follows. Two on January the 11th, one on the 13th, one on the 16th, one on the 19th, one on the 23rd (fatal on February the 8th), two on the 26th, one on the 28th (fatal on February the 11th), one on February the 5th (fatal on the 10th), one on the 13th, one on the 14th, one on the 22nd (fatal on March the 3rd), one on the 23rd, one on the 24th, three on the 25th (one of which fatal on

March the 5th), *five* on the 26th, one on the 27th, three on the 28th, three on the 29th, *seven* on March the 1st, and on the 2nd *ten* at once.

I give these dates and numbers, thus literally, because they are characteristic.

Obviously, they represent not the sudden striking down of a multitude by a morbific cause common to them all, but the gradual growth of a contagion gathering strength as it goes.

It is the exact counterpart of what, in the other contagious fevers, under similar conditions, we see every day.

At the date of my arrival, on February the 29th, very nearly thirty young women were already in bed with the fever, and within forty-eight hours *twenty* more were added to the list.

By March the 2nd more than fifty of the inmates had been stricken, three had already died, and two more, including the chaplain, who fell a victim to his devotion to the sick, were lying at the point of death.

Such, in an establishment in which, hitherto, no single case of typhoid fever had ever occurred, were the fruits of the doctrine that 'typhoid fever is the result of bad drainage only, and is not in any way contagious.'

It is not easy to describe the panic which prevailed at the convent. The great number of the sick, and the rapidity with which the fever was now spreading, were, in themselves, sufficiently appalling.

But there was one circumstance which added immeasurably to the anxiety. The nuns, themselves, had long become convinced that the fever was, in some way, spreading by contagion, and naturally looked to separation as the only means of staying it. But this was a reformatory, and reformatory is only another name for a prison. All the inmates were here under sentence, and could not be sent away until their term had expired. Up to this time a certain degree of isolation had been effected. Two wards had been set apart for the sick, but these were now entirely full. In the event of any further extension of the disease further separation was impossible.

More than fifty of the inmates, as we have seen, had already been attacked, seventy remained who up to this time had escaped. What was to prevent these seventy, or, at any rate, a large proportion of them, from sharing the fate of their fellow-prisoners? Such were the questions which were anxiously addressed to me on my arrival. What wonder that to the uninformed the dilemma should appear to be inexplicable.

Here was a great conflagration rapidly spreading, and a mass of combustible material close at hand which it was impossible to get out of the way. Conditions more unfavourable to prevention it is not easy to conceive.

One very important preventive measure—the pouring a disinfectant into the drains—had been adopted about a week before my arrival.

The further measures recommended for arresting the spread of the fever were the following:—

1st. Flooding again all the drains of the place with disinfectants, with a view to destroy, as far as possible, the poison already cast off.

2nd. The reception of all discharges from the sick, immediately on their issue from the body, into vessels charged with disinfectants also.

3rd. The instant immersion of all bed and body linen used by the sick into a disinfecting liquid, before its removal from the ward.

4th. Scrupulous ablution and disinfection of the hands of the nurses, whenever soiled by any offices rendered to the sick. And lastly, the burning or disinfection of all beds occupied by the sick, as soon as vacated by death, convalescence, or otherwise. All these things to be done, not in a loose or slip-slop way, but with the thoroughness and precision of scientific processes conducted in a laboratory. Under these conditions, and I am happy to say that they were fulfilled to the letter, I ventured to predict that the plague would be stayed. The prophecy was more than verified by the events. Twenty-six persons were indeed seized with the fever after the date of my first visit, but as twenty of these fell ill within the first forty-eight hours, they may at once be struck off the list. The average duration of the latent period in this fever, when, as in this case, the infection spreads through the air, being about fourteen days, these twenty persons must all have received their infection long before the preventive measures came into force. Of the remaining six, three more may probably be excluded on similar grounds. So that three only could, with any certainty, be counted as having become infected after the institution of the disinfecting plan.

Two great masses, one of infected and the other of uninfected, still remained, nevertheless, in close juxtaposition. For many weeks, yet, some forty or fifty fever-patients continued to discharge, as profusely as before, their poisonous excreta, but the chemicals placed in the vessel which received these excreta placed a barrier between the sick and the sound, which the contagion could not pass.

To complete the general history of this remarkable outbreak it is well to add that, with the exception of four cases, the fever was confined, from first to last, to the reformatory, into which it was originally imported. Of the four who, although not inmates of the reformatory, yet caught the fever, two were penitents who, alone of their class, were employed in the laundry; one was a nun who nursed the sick, and the fourth, the chaplain, who spent all his days in attendance on them. The two penitents, when they fell ill, were immediately placed in the sick ward with the other fever-patients, while in the case of the nun and of the chaplain disinfection was, from the date of my first visit, thoroughly carried out, so that the disease did not spread.[39]

It must not be supposed that the result here related, striking as it is, is in any way exceptional. My whole experience, on the contrary, extending now over a period of nearly thirty years, is in the most exact and absolute conformity with it.

In the month of November 1863 I was asked by my friend, Dr. Parsons, to come to Frome, in order to confer with him and some other medical men as to the steps to be taken to repress an outbreak of typhoid fever which had grown to formidable dimensions there, and had proved very fatal. The history of this outbreak was in one important respect the counterpart of that of Arno's Court.

The disease had been brought to Frome by a female pauper, who, having had typhoid at Bridgewater, was sent, while scarcely convalescent, to Frome, which was her proper parish. The journey brought on a relapse, and she lay for some weeks at a lodging in a small court there in a very dangerous state. Among other things it may be noted that the diarrhoea in her case was especially profuse.

A few weeks after her arrival, several persons living in the court and in the adjoining street were seized with typhoid fever, and the disease, spreading from that point, gradually infected the whole of the immediate neighborhood. At the date of my visit, some forty cases, or more, had already occurred. The measures taken to prevent the further spread of the disorder were identical with those which were put in force at Arno's Court. The only other precaution taken, was to close one or two wells, which from their proximity to drains or privies, were in danger of being tainted.

As the measures were identical, the result was identical also. A few persons were attacked afterwards, but from the date of their illness it was clear that they had received their infection before the institution of the disinfecting method.

It may be interesting to add that the disinfectant used was a solution of chloride of zinc, of which, fortunately, there happened to be a manufactory near at hand. This liquid, diluted with water in the proportion of one in forty, was poured several times a day into every public and private drain in the infected neighbourhood.

Altogether, nine hogsheads of the diluted solution were used in these operations.

Of typhoid fever in schools my experience is striking confirmatory of these results. I could name many large schools, in which, in former years, outbreaks originating, each, in a single case, had spread through the school, causing several deaths, and well-nigh accomplishing the ruin of the proprietors. In more than one of these, fever having again occurred in the person of one of the pupils, led to my being consulted as to whether any means short of breaking up the school could be taken to prevent a repetition of the same fatal consequences. The opinion I gave was that, if isolation of the patient and disinfection were thoroughly carried out, things might be safely left as they were. It was, no doubt, a great responsibility to assume. But I had ascertained in each case, that the drinking-water was beyond all risk of contamination, I felt that I could rely on the people, and to make assurance doubly sure, and to forestall any danger from possible negligences or lapses, I had the cisterns, which supplied the water closets, permanently charged with powerful disinfectants.

The event, in each case, entirely justified my confidence. In neither of these schools did the fever extend beyond the first case.

But why multiply instances, when the result is unvarying and can be stated in a single sentence?

In no single case that has ever fallen into my hands has this method failed to prevent the extension of this fever when applied from the first, or the further extension of it, when it has already been allowed to spread.[40] I have come, therefore, to look upon the method as infallible.

With these facts the cycle of evidence becomes complete. In all attempts to determine the relations of agents that are invisible, science is, rightly, exacting of proof. That a theory fits the phenomena is not, alone, enough. When the theory in question is of a nature to admit of being put to a practical test, we must show, also, that it will work. In the case before us we have satisfied both requirements.

The theory is, that the fever is spread by the discharges: in practice it is found that disinfecting the discharges always prevents the fever from spreading.

CHAPTER VII

The Pythogenic Theory of Typhoid Fever Irreconcilable with the Prolonged Absence of This Fever Frequently in Places Where Putrescent Effluvia Are Habitually Rife. Also with the Low Rate of Prevalence of This Fever on the Banks of the Thames in the Summer of 1858, When That River Stank So Badly

'Non da effluvj [*sic*] putredinosi, non da vicissitudini atmosferiche, anco [*sic*] le più stravaganti e teribili è da ripetersi adunque la causa delle malattie contagiose.'[41]

—Brera

It must be well known to most readers that the theory of typhoid fever propounded in the foregoing pages, whatever may be thought of it by scientific men, is not the theory which is generally accepted.

That this is a disease, which, like small-pox and the other contagions of the same order, is maintained solely by self-propagation, is a proposition which, as yet at least, is widely remote from the popular belief.

By the public at large, at any rate, organic matters, and especially sewage in a state of decomposition, without any relation to antecedent fever, is still generally supposed to be its most fertile source.

So widely, indeed, has this view been adopted, that an attempt has been made, and very nearly successfully made, to embody it in the very language of science.

'Pythogenic' fever, or, in other words, a fever born of putrescence, is the epithet by which it has been sought to engraft this doctrine in the name of the fever, itself.

In the foregoing chapters I have brought forward evidence to show that while this doctrine is irreconcilable with what is most characteristic of the manner in which this fever is propagated, the facts on which it is founded may be readily and far more satisfactorily explained in another way.

It is the purpose of the present chapter to further show that this doctrine is untenable even on its own grounds.

In studying the march of scientific discovery, there are few lessons more strongly impressed upon us than this: that a theory which merely embodies an inference drawn from a single order of facts is, for that reason, almost sure to be wrong, however clear and inevitable the inference, itself, may at first sight seem to be.

Philosophy teaches us why this should be so; experience illustrates the fact by a long list of signal examples.

There are, no doubt, cases, and that of contagion may be named as one of them, in which the relations between events really are, in general terms at least, what from the first they appear. But this can only happen when the fact on which we chance to light is one of a high order.

From the infinite complexity of things, it necessarily follows that such cases are few in comparison with those in which the direct contrary holds. It is not often that nature 'wears her heart on her sleeve,' or delivers up her secret at the first summons. Quite as often it seems to be her mood to mislead by deceiving shows, as if in counterpart of the principle by which man is said to have invented language for the concealment of thought.

It should be especially borne in mind in connection with the question about to be discussed, that *prima facie* evidence, which to the common eye seems irresistible, offers no guarantee that the conclusion on whose behalf it is cited, may not be utterly false. Illustrations of this must be familiar to all who are acquainted with the history of science. The conviction held so undoubtingly, for so many ages, that the earth is immovable; that it is the centre of the universe, and that the sun and stars revolve round it, and were made for its use, is a very striking one. Sir J. Herschel has made the pertinent remark that, in astronomy, nearly all the facts are, in reality, exactly the opposite to what they at first appear *with such certainty* to be. The notion held as undoubtingly, and for a still longer time, that mildew and kindred organisms are the actual offspring of damp and decay, is another case in point. Founded, like these discarded figments, on an induction from which the most capital facts were excluded, the theory that typhoid fever is actually caused by the chemical compounds which result from the decomposition of organic matters, is evidently destined to share in their fate.

On the other hand, it is characteristic of theories which, like these, are the expression of simple and overt relations, to obtain a strong hold on the popular mind. Suggested in the first instance by an obvious fitness, which, although superficial, is not the less striking, they soon gain general acceptance, and pass without challenge. From the nature of the case, a large number of phenomena fit the formula, and the convenient class of 'anomalies' and 'exceptions' is there to receive the rest. When a theory of this sort has once become widely current no rival theory (unless it be within the circle of the exact sciences) has, for a time, at least, any chance of a fair hearing.

Acclinis falsis, animus meloria recusat.[42]

The Copernican theory of the heavenly bodies had a hard battle to fight before it finally drove the Ptolemaic view from the field; and the ancient doctrine would, no doubt, have survived still longer, had it not been that the new one, from being founded on mathematical proof, was of a nature to compel belief. Even to this day, the Chinese, who, whatever else they may be, are a cultivated and intellectual people, treat as an insult to the understanding the notion that the earth is a moving body—a notion which, in their eyes, is in such flagrant contradiction with the plainest evidence of the senses.

As to the question before us that of the origin and mode of spreading of typhoid fever—there can be no doubt as to which side the weight of evidence belongs.

The whole of the evidence recorded in the preceding pages concurs in showing that the power to propagate this fever which sewers and other *cloacae*, undoubtedly possess, is due, not to common impurities, but to their frequent impregnation, in the way there described, with the actual fever-poison. To see that this is the true interpretation of the facts, all that is necessary is to contrast the experience of large towns in regard to this fever with that of country places. In large towns, typhoid fever is being continually traced to sewer emanations: because, from the constant presence of the disease in large communities, the sewers provided for them are as constantly being infected with the fever-virus. But, in villages and other places of small population, where, especially if remote from large towns, the disease is only an occasional visitor, the emanations to which it is commonly ascribed may continue in full force for years, together, without a single case arising.[43]

I have already stated in a former chapter, that before the great epidemic broke out which visited North Tawton so severely in 1839, there had been for fifteen years not more than one case of fever in the village.

Instances of the same prolonged absence of fever, in rural districts, in the presence of its reputed causes, might be multiplied to any extent, if, there were need.[44]

But, that the occurrence of these long intervals of rural exemption is not to be traced to any want or feebleness in country places of the fever-producing power is further plain from this, that when the disease does break out in them, the ratio of persons attacked is incomparably greater than is ever seen in the city under the like circumstances.

Speaking of the fever which swept the parish of Great Horwood in 1857–58, Prof. Acland says:—'An endemic affecting a similar proportion of the population of London would attack, in nine months, more than a quarter of a million of persons, of all ages; above fifty thousand would die of the fever alone, while the deaths from other causes during the period would not diminish.' (*Fever in Agricultural Districts*, by H. W. Acland, M.D., F.R.S., Regius Professor of Medicine in the University of Oxford.)

The North Tawton epidemic would lead to a similar calculation; while the two Caumont epidemics described by Gendron de l'Eure, and great numbers of the village outbreaks, recorded in the admirable 'Rapports des Epidemies' of the Memoirs of the French Academy, would carry a proportionate metropolitan mortality to a still more enormous aggregate.

It will be seen, from the bare statement of them, that figures like these represent an amount of havoc, in proportion to population, to which no urban outbreaks offer the most distant approach. And, as if to remove the last doubt as to what is the inference to be drawn from this contrast, this immensely greater havoc occurs, *precisely because the village is worse off than the city in regard to those very conditions out of which, according to the commonly received theory, typhoid fever is supposed to spring.*

I have already shown that the rapid and wide dissemination of the pest at North Tawton—and the remark applies with the same strictness to all similar village outbreaks—was caused by the almost entire absence of sewerage; i.e., of means for preventing the discharges from the human intestine from polluting the soil and air of the inhabited area.

Nothing can well be more simple than the interpretation of these relations. Village life, not only in England, but in Europe generally, is constantly presenting to us the following conditions:—

1. Sewerage entirely wanting, or very defective; and the resulting pythogenic compounds rife in proportion.

2. Typhoid fever wholly absent for long periods of time, notwithstanding.
3. Great virulence and inordinate spread of the fever when imported, by reason of, and in proportion to, the defective sewerage.

The long continued and entire immunity from the disease amid the impurities to which it is commonly ascribed, especially when contrasted with its intense virulence when once introduced, shows, with a force of evidence which in medical problems is rare indeed, that these impurities have no power of themselves to cause fever, but only when, in the course of events, they happen to become charged with its specific poison.

One of the most striking testimonies to the truth of this theory consists, indeed, in the *perfect explanation* it gives of two facts *absolutely, inexplicable* on any other grounds. I speak of the incomparably greater ravages which, as we have just seen, typhoid fever commits among rural communities when it attacks them, and its vastly greater apparent contagiousness in country than in town. Both these facts had been remarked over and over again by writers on the subject, but all had confessed their inability to explain them.

In referring to the evidence of the contagious nature of typhoid fever already recorded before the date of his own memoir on it, M. Piedvache says:—'All these observations (by Gendron de l'Eure, Leuret, Bretonneau, Ruefz, Putegnat, Patry, Jacquez, Ragaine) have been drawn from the country, or from towns of small population. The medical men of great cities, on the contrary, have scarcely observed any but facts negative of contagion. M. Gaultier de Claubry, who is an avowed partisan of contagion, could only muster, from his own practice, eight examples of it, for his paper on the subject, read to the Royal Academy of Medicine. In the discussion that followed, as well as in the discussions which took place on the occasion of the reading of the other memoirs I have cited, the members of the Academy admitted, some to have seen one, and others, two, three, or, at most, four cases, in which they could recognise the operation of contagion; others denied it altogether, on the ground that they had never seen an instance of it!' (*Mémoires de l'Acad. De Méd.*, 1850, p. 246.)

In another passage of the same memoir, M. Piedvache adds:—'The observations which I have recorded as proofs of contagion were nearly all collected in the country. The third, fourth, fifth, sixth, and thirty-seventh, were the only exceptions; and in none of these did that extension of the disease to the whole family occur, of which I have related several examples, and which I have so often witnessed.'

'These facts,' he continues, 'which are in accordance with all hitherto published, lead to the conclusion that typhoid fever, while almost invariably contagious in country places, is only rarely so, and by exception, so to speak, in cities. It is a general fact, which it is impossible to deny; but it is, if I may so express myself, a crude fact *(un fait brût)*, *'whose explanation is yet to seek.'* (*Ibid*., p. 308.)

To the common view, so great and so strange a contrast must seem in the highest degree perplexing. For, in town and country, as I have before observed, the fever itself is one and the same. It is not, in reality, less contagious in one place than in another. To multiply and throw off a specific poison constitutes, in town and country alike, its very essence. No one has yet suggested, in explanation of the seeming anomaly, that this pest has human sympathies, and is more merciful to the townsman than to the rustic. And few, I imagine, would be disposed to follow the cautious Louis, who, in the act of admitting this fever to be contagious, thought it necessary to add—not by the way of humour but in the sober sense of the words—'at least, in the departments' (*'au moins dans les départements'*).

The fact that this fever spreads almost wholly by the discharges from the intestines gives a perfect solution of the enigma.

In the city, in a large proportion of cases, these discharges are no sooner cast off than they are swept out of harm's way, or are otherwise dealt with in a manner that prevents their taking effect on the group who watch the sick bed. In country places, they accumulate day by day *on the open soil* which surrounds the patient's dwelling, until they envelope the whole household, and often the neighbours also, in a fever-miasm, *which is incomparably more virulent than the atmosphere of the sick chamber itself.*

In a paper which appeared in the 'Lancet' on the 6th December, 1856, on the Fever at the School of the Clergy Orphan Asylum,[45] I pointed out the working of these conditions in terms to which I have nothing to add. In the paper referred to, after observing that the case is, happily, one in which the natural instincts suggest what science prescribes, and that the rich, in using disinfectants to get rid of bad smells, often accomplish a higher purpose, it is added:—'Amongst the poor such refinements are never thought of; and when this fever breaks out in a poor family, the discharges from the bowels are thrown, without preparation, either into the common privy, or, as I have seen a hundred times in rural districts, are cast upon the dungheap, or into the open gutter. From this point, following the line of watershed, this pestilent stuff often makes its way to considerable distances, where, appearing now under the guise of an endemic miasm, which entirely masks its true origin, it may carry disease and death into many an unsuspecting household.'

The following extract from Mr. Simon's 'Report on the Public Health' in England in 1860, will show how true to fact these statements were.

In an account of an epidemic which ravaged the village of Dronfield, in Derbyshire, he says:—'Among details reported by the inspector was one which, notwithstanding its disgustingness, deserves particular notice; he was informed that, recently, below one house where typhoid fever was present, a long track of blood, descending the hill-side, marked the tract where the diarrhoeal excrements had been thrown, and let run *past two rows of houses into the turnpike road.'* (p. 12.)

The need of some radical modification in the view commonly taken of the relation which subsists between typhoid fever and sewage was placed in a very striking light by the state of the public health in London, during the hot months of 1858 and 1859, when the Thames stank so badly.

The late Dr. McWilliam pointed out at the time, in fitting and emphatic terms, the utter inconsistency of the facts with the received notions on the subject. Never before had nature laid down the data for the solution of a problem of this kind in terms so large, or wrought them out to so decisive an issue. As the lesson then taught us seems to be already well-nigh forgotten, I may, perhaps, be allowed to recall some of its more salient points.

The occasion, indeed, as already hinted, was no common one. An extreme case a gigantic scale in the phenomena, and perfect accuracy in the registration of the results—three of the best of all the guarantees against fallacy—were all combined to make the induction sure. For the first time in the history of man, the sewage of nearly three millions of people had been brought to seethe and ferment under a burning sun, in one vast open *cloaca* lying in their midst.

The result we all know. Stench so foul, we may well believe, had never before ascended to pollute this lower air. Never before, at least, had a stink risen to the height of an historic event. Even ancient fable failed to furnish figures adequate to convey a conception of its thrice Augean foulness. For many weeks, the atmosphere of Parliamentary Committee-rooms was only rendered barely tolerable by the suspension before every window, of blinds saturated with chloride of lime, and by the lavish use of this and other disinfectants. More than once, in spite of similar precautions, the law-courts were suddenly broken up by an insupportable invasion of the noxious vapour. The river steamers lost their accustomed traffic, and travelers, pressed for time, often made a circuit of many miles rather than cross one of the city bridges.[46]

For months together, the topic almost monopolised the public prints. Day after day, week after week, the 'Times' teemed with letters, filled with complaint, prophetic of calamity, or suggesting remedies. Here and there, a more than commonly passionate appeal showed how intensely the evil was felt by those who were condemned to dwell on the Stygian banks. At home and abroad, the state of the chief river was felt to be a national reproach. 'India is in revolt, and the Thames stinks,' were the two great facts coupled together by a distinguished foreign writer, to mark the climax of a national humiliation. But more significant still of the magnitude of the nuisance was the fact that five millions of money were cheerfully voted by a heavily taxed community to provide the means for its abatement. With the popular views as to the connection between epidemic disease and putrescent gases, this state of things naturally gave rise to the worst forebodings.

Members of Parliament and noble lords, dabblers in sanitary science, vied with professional sanitarians in predicting pestilence. If London should happily be spared the cholera, decimation by fever was, at least, a certainty. The occurrence of a case of malignant cholera in the person of a Thames waterman early in the summer, was more than once cited to give point to these warnings, and as foreshadowing what was to come. Meanwhile, the hot weather passed away; the returns of sickness and mortality were made up, and, strange to relate, the result showed, not only a death-rate below the average, but, *as the leading peculiarity of the season*, a remarkable diminution in the prevalence of fever, diarrhoea, and the other forms of disease commonly ascribed to putrid emanations.

After describing in scientific and forcible terms the unprecedented state of the river, Dr. Letheby adds:—'With all this condition of the Thames, however, the health of the metropolis has been remarkably good. In the corresponding period of last year (i.e., of the year 1857) the cases of fever, diarrhoea, and dysentery, attended in the city by the medical officers of the unions, amounted to 293 of the former and 181 of the latter; but during the past quarter (*i.e.*, the quarter of intolerable stench), they were only 202 of the former, and 93 of the latter!'[47]

So that, while pythogenic compounds were poisoning the air with what may be called a forty thousand fever-power, the so-called pythogenic fever, so far from rising in proportion, fell much below its average.

The testimony of Dr. McWilliam, as medical supervisor of the water-guard and waterside custom-house officers, is still more to the point. The former, to the number of more than 800, 'may be said to *live on the river or in the docks, in ships, or in open boats;* and the latter, numbering upwards of 500, are employed during the day *in the docks, or at the various wharves of the bonded warehouses on each side of the river.'* After stating that the amount of general sickness among these men was below the average of the three preceding years, and considerably below that of the year 1857, he adds, 'that as regards the types of those forms of disease (including diarrhoea, choleraic diarrhoea, dysentery, etc.) which, in this country, noxious exhalations are commonly supposed to originate, we find the additions during the four hot months of the year from this class of complaints 26.3 [percent, Ed.] below the average of the corresponding period of the three previous years, and 73 per cent less than those of 1857.' In another passage this distinguished physician says:—'It is nowhere sustained by evidence that the stench from the river and docks, however noisome, was in any way productive of disease. On the contrary, there was less disease of that form to which foul emanations are supposed to give rise, than usual.'

Before these inexorable figures the illusions of half century vanish in a moment.

To the argument against the pythogenic theory of typhoid fever, founded on the prolonged absence of the disease in places where pythogenic compounds are rife, there is only one possible objection that yet remains to be disposed of. The specific poisons, it may be said, by which the exclusively contagious diseases—such as small-pox, for instance—propagate, by the very nature of the case, never die out from among us. But, although always somewhere extant, it is only now and then, when season and other conditions conspire, that they display their full power over men. To hold, because their action is often dormant, that it does not exist, would be simply absurd.

In the same way, it might be argued that, if fever is often absent where the agencies to which fever is commonly attributed are rife, it is not because these agencies have not the power ascribed to them, but simply because the general conditions are wanting to give this power effect. It is scarcely necessary to remark that the analogy on which this objection is founded is imperfect in all the points essential to give it force. But, supposing it were otherwise, and admitting the argument to have a *primâ facie* claim to be considered, the circumstances which characterise the spread of this fever show at once that it does not meet the case. It requires but small acquaintance with the history of fever-outbreaks to know that the difficulty cannot be thus explained. Nothing can prove this more conclusively than the fact which may be witnessed every day in some part of the kingdom, that of two places in the same neighbourhood, situated exactly alike as to sanitary and other conditions, one may be the seat of a virulent epidemic of this fever, while the other remains perfectly free. In respect of defective sewerage, the place from which the disease is absent may be (as I have often seen) the worse of the two.

The admirable papers by Gendron de I'Eure on the epidemics of small localities; the writings of the illustrious Bretonneau; the annual reports of the French Academy of Medicine on the epidemics of France; and, lastly, not to add further to this list, the essay of M. Piedvache, are full of the most striking cases in point.

Examples of the same kind have occurred over and over again in my own practice. The epidemic at North Tawton, from—which I have already drawn so largely, was a very complete one. I have already referred to that epidemic to show that the prolonged immunity from typhoid fever, which the village had previously enjoyed, was fatal to the hypothesis that common sewage emanations had any hand in the scourge which at length fell so heavily upon it. The violation of all reason involved in this hypothesis was rendered still more apparent by taking a wider survey. For, at the very time when typhoid fever was so rife in North Tawton, all the other principal villages in the neighbourhood remained entirely free from it. And yet, not only were many of them far worse off than North Tawton, in respect of drainage, but there was one, the village of Exboum, four miles away, that had long been a by-word in the country for its flagrant neglect of sanitary precautions. Pools of foul and stagnant water, dungheaps, open cesspools, and every other conceivable nuisance, abounded in the place. If the like impurities were the cause of the fever which was raging at North Tawton, how did they happen to have no such effect here, where they were so much more rife? It could not be that the season was not favourable; neither could it be that there was no food for the disease. For when the same fever was introduced into Exboum, fifteen months later, it spread there, also, with great virulence, and, as if to complete the demonstration, when it had already died away in its former seat.

This is a history which admits of but one interpretation. For if upon the hypothesis that typhoid fever is caused by common malaria, irrespectively of contagion, facts like these are perfectly inexplicable, few, I presume, can have failed to perceive that, as incidents occurring in the erratic progress of a contagious disorder, they are entirely, and in every point, consistent with our other experience.

The history of which the leading features have just been rapidly sketched is, in fact, emphatically, the history of a disorder of this kind. *Mutatis mutandis*,[48] it is the history of small-pox; it is the history of measles; it is the history of scarlet fever; it is the history of malignant cholera.[49] In all these specific contagions we meet with these same alternations of slumber and activity; of wide-spread prevalence in one place, while other places hard by remain free; and finally, with the same successive invasion of neighbouring places, in such wise, that the reigning disorder be it small-pox, measles, scarlet fever, typhoid fever, or malignant cholera often only begins to prevail in the new locality when it has already died out in the old.

It is, in fact, in a general survey of this kind that we get the clearest view of the thread which really connects all these events. Running through all these circumstances, there is plainly but one thing constant; namely, a specific morbid cause—a cause which is neither a permanent product of the soil, or air, or of particular seasons, but which is susceptible of transmission from place to place; which breeds as it goes, and then again dies out or becomes dormant, without leaving any sign to mark its track.

There is only one thing of which these can be the characteristics; and that is, the specific poison bred of the disease and by which the disease propagates, and which, in common with the other specific poisons perpetuated by the same law, possesses all these properties.

The Pythogenic Theory of Typhoid Fever, Further Irreconcilable with the Intensely Specific Conditions which Attach to the Reproduction of the Fever Poison in the Living Body. The Enormous Rate of this Reproduction Adequate to All the Phenomena

In a leading article which appeared in the 'Medical Times and Gazette' for February the 9th, 1861 under the heading 'Abandonment of the Doctrine of the Specificity of Contagious Diseases,' the writer states that, one by one, authors and observers are declaring their belief that these diseases 'may originate *de novo* out of the dirt and neglect which surround us.' After quoting the opinions of many eminent authorities, in proof of his assertion, he adds that the paper lately read to the Epidemiological Society by Dr. Milroy[50] applies the same idea still more widely, and 'shows a tendency in the professional mind to adopt new and what may be called liberal views.'

All the vague and untenable notions which have of late years gathered round this subject, more particularly in relation to the propagation of typhoid fever and some other epidemic disorders, may be traced either to ignorance of their contagious properties, or to want of insight into what contagion involves. 'If once a disease of this kind,' says Sir T. Watson, in his pleasant and masterly discussion of this subject, 'is decidedly proved to be the effect of contagion, we cannot help entertaining a doubt whether the disorder in question really ever has any other cause.' The more we reflect on this observation, the more just it will appear. In a former chapter I have already shown that, in typhoid fever, dissemination by contagion implies precisely what it implies in small-pox and that it is provided for, in the same way, by the multiplication of a specific poison in the most intimate recesses of the living body, by that most remarkable of processes which constitutes the phenomena of a contagious fever.

Even on the most superficial view, it is difficult to suppose that an agent which is evolved by such a process as this can be the offspring of any other. Still more difficult is it to suppose that an agent so evolved can be the product of merely external conditions. To see in all its force how intensely specific a thing the propagation of these poisons in the human body is, we must bear in mind that they are not one, but many. Multiplying in the same remarkable medium—bred, therefore, of the same organic materials, and, what is still more, by the same peculiar law—yet each of these several poisons sets up a series of changes which always issues in the reproduction of its own specific kind—small-pox in small-pox, scarlet fever in scarlet fever, and so on of the rest. What small-pox and measles were in the Arab in the days of Rhazes, they still are in the Londoner, they are in the wild Indian of the North American prairie, and in the Negro of the Gold Coast. To all the other contagious fevers, as far as our records go, the same are in the Londoner, they are in the wild Indian of the North American prairie, and in the Negro of the Gold Coast. To all other contagious fevers, as far as our records go, the same remark applies. In races the most diverse, under climates the most various, age after age, through endless generations of men, these diseases pass down through the human body, perpetuating their own kind, and each maintaining its separate identity by marks as specific as those which distinguish the asp from the adder, or the hemlock from the poppy. To say the least, it is difficult to conceive that agents of whose propagation this is the history can be generated in any other way.

An additional argument to the same effect may be drawn from the fact that many of these fevers are peculiar to man. This seems to be especially the case with the fever before us.

If the poison from which typhoid fever springs were capable of being bred elsewhere than in the human body, it would surely be in the bodies of animals which are made of flesh and blood like ourselves, and from whose substance we draw sustenance for our own. And yet it appears to be almost certain that this is not the case. In the most virulent outbreaks of typhoid fever, there is no evidence that even the domestic animals which gather round the fever-stricken dwelling ever take the disease. At Chaffcombe, while nearly all the *human* inmates of the infected homestead were laid low by the poison, the dogs and cats which belonged to the house, and the poultry, pigs, horses, and cattle which thronged the yard, continued to enjoy perfect health. Yet the pond from which the latter drank was being continually polluted by a drain which received the whole bulk of the intestinal discharges from the fever-patients.[51] I have observed the same striking contrast in other instances without number; and I may add, that the whole course of observation bears out the conclusion to which this contrast so distinctly points.[52]

But if the fever-poison cannot find the elements of its growth even in the animals which are the most closely connected with man—in the material conditions, that is to say, which of all others most nearly resemble those of its known mode of development—what likelihood is there of its being the offspring of conditions so radically different from these as those which are presented by common dead matter? If it cannot breed in the bodies of the cat, the dog, the pig, the horse, or the cow, how can it be conceived to breed in every ditch or dungheap?

The force of this argument is immeasurably added to when we further consider that, even in the body of man himself, the reproduction of the fever-poison requires conditions of its own.

One of the most cardinal points in the history of the remarkable family of agents of which this poison is one, is, that predisposition in the subject is essential to the development of their specific power. Deadly as they are where this predisposition exists, where it is wanting, they are of no effect. A given dose of carbonic acid or of sulphuretted hydrogen is fatal to all men alike; but of fifty men who receive an equal dose of the poison of small-pox, or typhus, or typhoid fever, as the case may be, some are poisoned unto death, while others remain unhurt. This is a difference, not of degree, but of essence.

What may be the *intimate* nature of the conditions essential to give effect to the fever-poison, or of those which defeat its operation, we are as yet in no position to define. How subtle they may be we may learn from that most mysterious of facts already once referred to in these pages, which consists in the immunity conferred by one attack against a repetition of the same fever.

In small-pox, this immunity has been proved by experiment on an enormous scale.[53] In the other contagious fevers, although not open to experimental proof, an immunity of the same nature has been deduced from observation, which may be the more readily trusted because the singularity in question (however unable we may be to penetrate the causes on which it depends) is evidently connected in some essential way with the peculiar law by which the whole family propagate.

Like many others already mentioned, this too is, plainly enough, a family characteristic. But what a marvelous characteristic it is! Here are two subjects who in their power to resist all common external agents are, as far as we can discern, precisely alike. Living on the same food, breathing the same air, nearly of an age, following the same occupation, alike in feature; the children, it may be, of the same parents; and equal, as far as can be judged, in nervous and other power: and yet, in the one a few moments' exposure to the specific poison is often sufficient to cause death, while in the other a far greater exposure may be incurred for indefinite periods of time without the slightest ill effect.

To explain so great an enigma, chemistry can as yet demonstrate nothing, and physiology can only vaguely speculate.[54] Neither in the flesh nor the blood of the two men; neither in their form nor feature, nor any other attribute, is any trace to be discovered, by present methods, of a difference so momentous. But, whatever may be the nature of the conditions on which this difference depends, they are all summed up in the fact that the man who suffers has never had the fever before, while he who escapes has already gone through it.

Over and over again, I have seen instances of persons who have remained perfectly well where every one else has suffered, and whose immunity could only be reasonably explained by the protection conferred by an attack of the same fever at some former period. The nurses of fever hospitals, who have once had the disease, remain with few exceptions, for the rest of their lives entirely proof against it, although constantly exposed by their calling to greater risk of infection than ever occurs in any other condition of life.

But what is most striking of all is, that the attack which confers the future protection may occur in childhood, and the protection, nevertheless, be life-long. The child once marked with small-pox is proof against it as long as he lives, however early the date of the first attack; and in this, as we have seen, small-pox is but a type of the rest.[55]

The living substance, meanwhile, is in continual flux, and the body itself, to borrow the fine expression of Coleridge, is 'but the common phantom of a thousand successors.'

The case is even stronger than this. The figure of the poet, bold as it may seem, falls short of the truth. For it were vain now to trace in the finished man of forty or fifty either the form or the lineaments of the child who, in long past years, once had the fever. And yet, through all these changes of stature, form, and substance, the man of forty or fifty still inherits, as against this particular poison, the immunity which was purchased by the child in that one attack. Once dipped in the Styx, our Achilles comes forth invulnerable.

In the presence of relations such as these, it would seem as if science could only verify and record, without attempting to explain. So manifold, so subtle, so incomparably specific, are the conditions on which, even in the living body itself, the reproduction of the fever poison depends. If anything more were needed, in addition to all this, to show how specific a thing the reproduction of these poisons in the human body really is, and on what intensely specific conditions it depends, it would be found in the fact that the immunity acquired by one attack of these fevers holds good only as against its own particular poison, and is of no avail against the rest. Measles renders the body proof against measles, but leaves it as open to small-pox as before; and so on of the rest.

To conclude, on the evidence usually assigned for such a belief, that a poison, of whose growth this is the history, is bred in every cesspool or ditch in which there may chance to be a heap of seething rottenness, is precisely on a par with the philosophy which led the ancients to believe that mushrooms are bred of cow-dung, alligators of the mud of the Nile, and that bees, as Virgil sang, may be engendered in the entrails of a putrid ox. And signs are not wanting to show that the time is not far distant when the belief in question will take its place in that limbo of discarded fallacies to which these other superstitions have long since been consigned.

While, therefore, the great fact remains that sewers are the principal channels through which this fever is propagated, the proof from all sides is overwhelming that they are so not because of their being receptacles of decomposing organic matter, but solely because of their being the depositories of the specific discharges of persons already infected.

But if this be so; if the sewer only transmits the fever because it is tainted with the intestinal discharges of fever patients, there is, as I have observed before, no need of further argument to show that these discharges are incomparably more virulent than aught else that proceeds from the sick.

So completely, indeed, in the public mind, is this fever identified with sewer-poisoning, and so insignificant, in comparison, has seemed the part which mere personal intercourse has taken in its propagation, that the sewer has come to be looked upon as the actual and primary source of the disease, while the infected man has been altogether lost sight of. To such a degree has the prejudice thus arising operated, that not the vulgar only, but (until lately) even scientific men have refused to listen to the decisive evidence by which the disease is proved to be essentially contagious, and overlooking, thus, the bond which unites the two elements, have failed to discern the great truth that the sewer only owes its fatal influence to its connection with man; that it is but the channel for the distribution of a poison which it has no power to generate, and only acts in the work of dissemination by opening a wider sphere to the contagious principle.

On the other hand, there is reason to believe that *so long as it remains in the liquid state* the virus which issues from the intestines of fever patients is very easily destructible. Much of it is, no doubt, extinguished soon after its discharge from the body in process of natural change, or by the external agents with which it comes in contact. Much, again, is rendered ineffective by dilution, or is rapidly swept beyond the inhabited area by floods, or by effective drainage, and much too is dissipated or destroyed in other ways. From these several causes, it is certain that by far the greater part of what is cast forth takes no effect.

This is but the expression of a general law. Like all other types in nature that propagate by germs cast loose upon the world, a myriad perish for one that fructifies.

The ova developed by a single tapeworm would be enough, if they all came to their full estate, to people with tapeworm every extant human intestine. The spores of some dozen mushrooms would well nigh suffice to crop the planet with that fungus.

Where the springing up of heirs depends so much on chance, and may be defeated by so many contingencies, it is only by such lavish reproduction that the great law of continuous succession can be maintained.

> Autumn scatters its thousand seeds. Scarce one of the thousand
> Bringeth forth fruit; and the rest back to the element turn.
> Yet though one only expandeth its germ, that one only peoples
> Living creation with forms that through eternity last.[56]

What is true of organic life is, as I have elsewhere shown, true to the letter of these organic poisons also.

CHAPTER VIII
Spontaneous Origin

'Il vajuolo [*sic*] pare che talvolte sorprenda degl' individui che non ebbero communicazione co' vajuolosi [*sic*]. Eppure, egli è deciso, che il vajuolo[*sic*], sono undici secoli, era affatto sconosciuto in Europa, e che è rimasto sconosciuto in alcune isole del Mar Pacifico, fino a tanto che non vi penetraraono gli Europei.'[57]

—Brera

The position taken in the foregoing pages, broadly stated, amounts to this:—that typhoid fever is not only self-propagating, but that it originates in no other way.

For if it can be shown that even the products of the decomposition of organic matters, for which so strong a *prima facie* case can be made out, have, in reality, no power to cause this disease, there is no single plea for supposing that such a power resides in any other condition.

In reply to this, it has often been objected to me that it is impossible in such a problem to prove a negative. But, on the other hand, this alternative is clearly not required. It will be time enough to examine the claims of any other alleged cause when scientific grounds can be produced for advancing them.

In regard to this point, I may further observe that, if this fever really has an origin independent of contagion, facts giving *positive* and express indication of such origin, and incapable of explanation on any other supposition, are sure to make themselves known. Meanwhile, the question admits of being put to a very clear issue. With the exception of what relates to defective sewerage—a case already disposed of—the only plea for believing in the spontaneous origin of this fever is founded on evidence of a purely *negative* character, and consists, solely, in our inability to trace, with the eye, the continuity of a chain whose links are known to be invisible. To conclude from this that no chain exists is palpably absurd. When subjected to a careful analysis, the whole of this evidence resolves itself into the fact that instances of typhoid fever often spring up in which it is impossible to trace the disease back to a personal source of specific infection. But to this one would have supposed that it would have been sufficient to answer, that this impossibility lies in the very nature of the case.

For, as the fever-poison is invisible to the naked eye, at least its very existence being known to us by inference only—and as, from this and other causes too obvious to need special mention, provision is made for its dissemination in a thousand invisible ways, it necessarily follows, not only that the precise source of infection in any given case must often escape us, but that cases must *constantly* arise which, to the uninformed, bear all the semblance of spontaneous origin.

To distort facts which can thus be shown to be the necessary result of a *known mode of continuous propagation*, into an argument for a *de novo* origin, is to carry perverseness in reasoning as far as it can well go.

The question might fairly be left to rest on these grounds. The want of logic involved in the popular mode of solving it may, however, be placed in a still stronger light.

If we are required to believe that typhoid fever originates spontaneously, simply because in many instances we cannot trace the disease back to an immediate prototype, on the very same, or on still stronger grounds, we are bound to believe in the spontaneous origin of small-pox and the other self-propagating fevers.

In small-pox, indeed, not only do countless cases occur which cannot be traced to contagion, but the disease not rarely springs up under conditions where the idea of such a source would seem at first sight to be altogether shut out. When small-pox, some years ago, prevailed extensively in Bristol, it attacked simultaneously three persons who had been for a long while in-patients in three different wards of the Bristol Royal Infirmary. Of these three persons, one had been confined to his bed for more than a month with a fractured leg, another had for some time been altogether disabled, and the third had not left the Infirmary for many weeks. What made this example the more telling was that, although there was a good deal of small-pox in Bristol, there was none at the time in the immediate neighbourhood of the house.

Small-pox entirely disappeared from Boston in New England, seven different times; but in only three of the seven, in spite of the greatest pains taken in the investigation, could the channel of its reintroduction be discovered.[58]

Some years ago, an intimate friend of my own, living in a country house, was seized with small-pox, although he had not been away from home, and although there was, as far as could be ascertained, no other case within forty miles of the place. About thirty years since, an exactly similar instance fell under my own observation in the person of a young boy, in the village of North Tawton, who had never in his life been out of the village. In that instance there was certainly no other case of small-pox within a very wide radius of it.

The course of general observation is in entire conformity with these facts.

To those who have not attended to the subject it may appear strange, but it is nevertheless strictly true, that during a period—thirty years—I have scarcely ever met with an instance in private practice in which the patient first affected could trace the disorder to its source.[59] The late Dr. Gregory stated, in his article on Small-pox, in the *Cycloepadia of Practical Medicine*, that of the numerous cases received into the Small-pox Hospital, 'not one in twenty is capable of being referred to any known source of infection, the disease being ascribed by the patient to cold, fatigue, change of air, or some other innocent circumstance.'

Judging from my own experience of the two diseases, I can scarcely doubt that, if an accurate register of both were kept in town and country, it would show ten cases of small-pox to one of typhoid fever in which the origin of the disease could not be traced.

From these facts one of two things is clear: either small-pox, as well as typhoid fever, is constantly springing up anew, or the facts which are commonly supposed, in either case, to lead to that conclusion offer, in reality, not the slightest warrant for it. There appears to be no possible escape from this dilemma. I need scarcely add that the former alternative will be rejected at once by all who have well considered the subject.

Sir T. Watson has well remarked that the history of small-pox is decisive against the notion of its spontaneous origin. His precise words are these:—'I say the *history* of small-pox leads to the settled belief that this disorder, of which few persons are not readily susceptible, never occurs except from contagion. *It was quite unknown in Europe till the beginning of the eighth century.* No mention of any such malady is to be found in the Greek or Roman authors of antiquity. Now, whatever may have been the deficiencies of the ancient physicians, they were excellent observers and capital describers of disease; and it is impossible that a disease so diffusive, and marked by characters so definite and conspicuous, should have escaped their notice, or have been obscurely portrayed (if known) in their writings. On the other hand, Mr. Moore, in his learned and interesting *History of Small-pox*, has shown that it prevailed in China and Hindustan from a very early period, even more than a thousand years before the time of our Saviour.'[60]

If anything were wanting to show what is the true inference to be drawn from these events, it would be found in the fact that, *once imported into the West,* 'whensoever or wheresoever the disorder came, it spread with the most fearful rapidity and havoc.' 'What I wish you to remark,' says the distinguished writer I have just quoted, 'is this: that while almost all men are prone to take the disorder, large portions of the world have remained for centuries exempt from it, until at length it was imported; and that then it infallibly diffused and established itself in those parts.'

That the conditions for the manufacture of the small-pox poison existed here in the most intense degree, was shown by the event when the disease itself was once introduced. The long lapse of ages during which we remained entirely free from it showed with equal clearness that until this introduction occurred, all those conditions were powerless to cause a single case.

The spectacle witnessed in Europe was repeated over again in the western world in a still more striking way. Our knowledge of the events in this instance is precise and sure. 'There was no small-pox in the New World before its discovery by Columbus in 1492. In 1517 the disease was imported into St. Domingo. Three years later, in one of the Spanish expeditions from Cuba to Mexico, a negro covered with the pustules of small-pox was landed on the Mexican coast. *From him* the disease spread with such desolation that within a very short time, according to Robertson, three millions and a half of people were destroyed by it in that kingdom alone.

'Small-pox was introduced into Iceland in 1707, when sixteen thousand persons were carried off by its ravages—more than a fourth part of the whole population of the island. It reached Greenland still later, appearing there for the first time in 1733, and spreading so fatally as almost to depopulate the island.'

Clearly we have here the history of a specific poison which no common conditions of human life, however various the climate, the people, the civilisation, or however defective the sanitary state, have the power to generate, but for whose propagation the actual virus of a pre-existing case is the one necessary and all-sufficient condition. Under this view, everything is explained in the most easy and natural manner. Adopt the opposite view, and we are driven to the most preposterous assumptions in order to sustain it. This may be made evident by applying the spontaneous theory of small-pox for a moment to our own case.

When small-pox was first imported into England, it spread, as everywhere else, with the most fearful rapidity. Then, as now, we may be sure but no doubt to a far greater extent than now, for Jenner had not yet thrown over us the aegis of vaccination in addition to those who could trace their disease to direct contagion, vast numbers were attacked who had held no communication with the sick. Then, as now, we may be equally sure, cases were frequently springing up under conditions of the most complete apparent isolation.

If the idea of spontaneous origin be necessary to explain such cases now, it was equally necessary then. So that the assumption we have to make is, that concurrently with the importation of small-pox into England, *but quite independently of that event*, the conditions of English life, which, for all time before, had been powerless to develop a single case, had suddenly acquired the power to breed the disease in the most prolific manner. I need scarcely add that the bare statement of a conclusion such as this is the best exposure of its extravagant absurdity.

Our difficulties, insuperable as they already are, would not indeed end here. For, even if all this were granted, we should further have to explain how it is that the English people, having once acquired so perfectly the art of brewing this specific poison, should by migrating to Australia and New Zealand, *have again altogether lost it*. Happily, as yet this particular scourge has not once made its appearance in either of these two colonies.

I may add that the philosopher probably does not exist who would not readily hazard the prediction that, if by neglect or mischance small-pox should be imported into these communities, they would at once appear to have recovered the power of breeding it and observers with more zeal than knowledge would there, as here, again point to isolated examples of it as proofs of its spontaneous origin.

The facts as applied to typhoid fever stand, therefore, thus:—Cases of this fever, like cases of small-pox, are constantly arising which cannot be traced to contagion. There is the strongest conceivable evidence, notwithstanding, that whatever its first origin, small-pox does not spring up *de novo* now. The occurrence of such cases is, therefore, no warrant for supposing that either of these diseases does so spring up.

Scarlet fever and measles teach the same lesson. In all countries in which these two diseases are established, cases are continually occurring in which, as in small-pox, it is impossible to trace a linear descent. But the geographical distribution of both, past and present, is fatal to the idea of spontaneous origin in either, and decisive in favour of their sole propagation by the law of continuous succession. To confine ourselves to a single illustration: The disease, measles, was quite unknown in Tahiti until about ten years ago. But, once imported, it spread like wildfire through the island, causing an amount of havoc among the natives, for which no parallel is to be found in European outbreaks of the same disorder. Even without going farther we might safely apply the conclusions drawn from the history of these three self-propagating fevers, small-pox, scarlet fever, and measles, to typhoid fever also. The four are, in the strictest sense of the words, members of the same natural family, and precisely as we may apply what we know of the propagation of one sort of mushroom to that of another sort, so we may apply what we know of one of these specific self-propagating diseases to the rest. But direct evidence is not wanting which, although less precise and absolute than in the case of the other three, is yet sufficient to warrant the belief that in its distribution over the earth, this fever, also, has followed the same law as they.

There is reason to think that its specific contagion continued, down to a comparatively recent period, quite unknown, in many parts of the world, where it is now rife.

Like small-pox and the other eruptive fevers, this febrile type appears not to have existed in Tahiti, until after the discovery and colonisation of that island by the European. Now, it is reported, the population is being rapidly swept off by two principal scourges, typhoid fever and phthisis; the latter, also, as some believe, imported from Europe.

It has been credibly reported to me that typhoid fever was quite unknown in Queensland, until it was brought there from England, in the 'Flying Cloud,' a fever-stricken emigrant ship. Since that date it is said to have become established in the colony. For obvious reasons I am unable to verify the statement, but if the circumstances really were what they have been represented to me to have been, they would be well worth inquiring into in relation to the question before us. Some record of this is, no doubt, still to be found in Brisbane.

I have read, somewhere, but am unable to lay my hand on my authority now, that when America was first settled, it was a long time before typhoid fever appeared among the colonists, and that a still longer time elapsed before it reached the great Mississippi valley, where, at present, it is very prevalent. Other illustrations of the same kind might be added to these, if there were need.

Taken as a whole it is impossible to conceive of anything more decisive than these facts. For—whatever may be thought of the case of typhoid—it will be observed that, in regard to more than one other of this great family of specific diseases, the evidence is as massive as it is precise.

There is not opening, here, for the thousand and one fallacies, which in experimental inquiries, for instance, are so apt to slip in undetected, through carelessness or want of skill in the operator. There is no opportunity for the distorting influence of theoretic bias. The testimony is too colossal to be warped. The elements of the argument are, in fact, Cosmic in their magnitude, and the conclusion to which they all unite in bearing witness, is, that, in whatever way these self-propagating types may have first come into being, they are never known to arise spontaneously now, but are perpetuated by the great law of continuous succession.

As if this were not enough, two other contagious fevers have lately been brought, in a memorable way, to the knowledge of the British people, under conditions that have added one link more to the chain of proof. I speak of Sheep's Small-pox and the Siberian Cattle Plague.

In these two diseases the evidence derived from their history and geographical distribution offers an exact parallel to that which we have just been considering. But here the inference drawn from it has been clenched by the crowning fact, that by destroying the diseased animals and the poison they have cast off, the plague itself is extinguished. The teaching value of the evidence thus furnished is greatly enhanced by the circumstance, that from its intimate relation to the food of the people, the subject has been brought home to the knowledge of the humblest amongst us.

Once more, as I write these lines, our cattle are threatened by the great

Siberian Plague, and so well known, now, is the right and only course to take for its suppression, that no one has any doubt that, by destroying the infection already laid, and slaying every stricken beast, this great scourge will be rooted out of England with the same certainty with which the breed of thistles would be exterminated, could we destroy every thistle seed and root up every thistle plant.[61]

But if the arguments set forth in these pages be sound, we are authorized by the severest induction in anticipating a similar result from our action against typhoid fever also.

We cannot, indeed, in this case slay the infected, but the fact that the poison which carries on the infection is cast off in a form that places it entirely within our power, enables us to bar the succession by which the disease is kept up.

There is no need of rooting up the thistle; destruction of the thistle seed is enough.

There still remains one objection to these views, on which a word must be said before I conclude. As all contagious diseases must, in the *first* instance, have occurred independently of contagion, it is often argued that there is every reason to believe they still do so.

This is the last refuge of the partisan of spontaneous origin.

M. Trousseau, who, although an avowed contagionist, is an equally firm believer in 'spontaneity,' has put the case very clearly. After observing that the spontaneous origin of contagious disorders is not only a fact that cannot be contested, but is an important element in the development even of the most contagious among them, he adds:—

> 'In fact, as contagion implies necessarily the presence of two persons, the one giving and the other receiving the morbific germ, it is too obvious that in the *first* person attacked by a contagious malady the disease must have developed itself spontaneously, and was formed out of its prime elements, under the influence of causes which are completely unknown to us.'[62]

Following up this view, this distinguished teacher suggests that many cases in which diseases of this kind spring up in isolated places can only be explained by supposing that the same thing still happens.

Small-pox, that is to say, having originated *de novo* once, must originate *de novo* now. For that, if it is to have any force at all, is what the argument, amounts to. But it is obvious, from what has gone before, that, if this argument applies to the specific contagions, no reason whatever can be shown why it should not also apply to animals and plants—not microscopic merely, but even to those of considerable size.

Itch, being a contagious disease, two persons are always necessarily implicated in its propagation. But there must have been a time when a *first* person had the itch without receiving it from another. The itch insect having originated *de novo* once, must therefore, according to M. Trousseau, originate *de novo* now. The two facts stand on exactly the same level.

But, the truth is, that the first origin of the germs of specific contagious diseases and of the great procession of organic types which have successively appeared on the earth is alike unknown to us. By the light of science, we know no more of the first evolution of the germ of small-pox or syphilis, than we do of the acarus which inhabits the human skin—of the tapeworm which was appointed to live in the human intestine—of the cystic worm which finds a temporary home in the brain of the young sheep—of the mistletoe which fastens on the oak—or of the different species of mildew which breed in the grain of wheat.[63] We know no more, by the light of science, of the first origin of *these* living types, than we do of the higher organisms on whose substance they feed.

The precise mode in which all these things first came into being is hidden from us by an impenetrable veil.

On the other hand, everything tends to show that, once created, they all propagate only in one way. That small-pox is only maintained by self-propagation, there are, as we have seen, the strongest conceivable reasons for believing.

The history of syphilis tells the same story. Who among us can say when, or how, or by what process, this terrible virus first came into being? Who can name the thrice unhappy man, on whose person, innocent of any unclean contact, it *first* implanted its foul venom? We all know how it propagates now, and that inoculation by the actual contact of two persons is essential to its continuance.

I have always thought it a very significant fact, that, in this case, where the process of transplantation can only be effected by an act of which two persons at least must be cognisant, the idea of spontaneous origin has never once arisen.

Let an isolated case of typhoid fever occur, and, merely because he cannot readily trace the disorder to its source, many a medical man will assert, without the slightest hesitation or doubt, that the disease has, clearly, originated spontaneously. Press him, and he will be ready, at once, with the argument that there is no reason why the conditions which *first* gave rise to it, may not again give rise to it now.

But let a young sinner with the peccant mark upon him swear ever so stoutly that the disease he bears has come on spontaneously; let him argue as plausibly and as long as he will against the incredulity which refuses to see that the conditions which *first* gave rise to this disease, may again give rise to it now, and the very same medical man will laugh him to scorn.

In small-pox and syphilis, where, from the nature of the facts, the evidence bearing on this question is precise and sure, the answer is unequivocal.

The history of these two diseases is at hand to show—as by a great standing experiment—that these specific contagions, so far from being things that spring up at every turn, have, in reality, come into being under conditions hidden in primeval darkness, and of which we have no experience.

The history of many other contagious maladies is precisely to the same effect. The very significant fact, already mentioned, of the exclusive appearance of many among them, in the first instance, in particular geographical centres, whence, sometimes only after the lapse of long ages, they have afterwards spread far and wide, leads to the same general conclusion.[64]

I have argued this question thus minutely because, in addition to the momentous practical conclusion that hangs upon it, a point of high equity is concerned in it. On all accounts, it is time that the opposite parties in this great debate—the contagionists and the anti-contagionists should be placed in their true, respective positions. Some years ago, at least, whenever and wherever this debate was opened, I observed that the contagionists were uniformly treated as if they, and not their opponents, were guilty of dealing—in assumption and going against evidence.

I need scarcely remark that the truth is precisely the opposite of this.

At all events, as regards typhoid fever and the other members of the same family group, the contagionist, alone, proceeds on the solid basis of fact, and, where direct evidence cannot be had, has the support of analogy of the closest and strongest kind.

We *know* that the poisons of small-pox and of typhoid fever are multiplied in the human body, as certainly as we know that corn is raised from its own grain. That these poisons are multiplied in any other way is not only pure hypothesis, but is an hypothesis that has besides the fatal defect of being entirely gratuitous—of being in opposition to all analogy that is of any worth, and of being, in one of these cases, at least, only tenable, at all, by heaping one extravagant assumption on another.

CHAPTER IX
Summary

'Ernst ist das Leben.'[65]

—SCHILLER

The conclusions arrived at in the foregoing pages may be summed up in the following propositions:—

1. That typhoid fever is, in its essence, a contagious, or self-propagating fever, and is a member of the great natural family of contagious fevers, of which small-pox may be taken to be the type.
2. That the living body of the infected man is the soil in which the specific poison, which is the cause of the fever, breeds and multiplies.
3. That the reproduction of this poison in the infected body, and the disturbance attaching to it constitute the fever.
4. That this reproduction is the same in kind as that of which we have, in small-pox, ocular demonstration.
5. That the disease of the intestine, which is its distinctive anatomical mark, is the specific eruption of the fever, and bears the same pathological relation to it which the small-pox eruption bears to small-pox.
6. That, as might have been anticipated from this view, the contagious matter by which the fever is propagated is cast off, chiefly, in the discharges from the diseased intestine.
7. That as a necessary result, sewers and the cloacae which, under existing sanitary arrangements, are the common receptacles of these discharges are, also, the principal instruments in the transmission of the contagion; and, consequently, that, in many instances, the infected sewer, and not the infected man, appears as if it were the primary source of the specific poison.
8. That once cast off by the intestine this poison may communicate the fever to other persons in two principal ways—either by contaminating the drinking water, or by infecting the air.
9. That, as an inevitable consequence of the impalpable minuteness of the contagious unit, and the many invisible and untraceable ways in which it is transmitted, cases must be constantly occurring, exactly as in the other contagious fevers, whose linear descent cannot be followed, and which spring up, therefore, under the semblance of spontaneous origin.
10. That the occurrence of such cases obviously constitutes no proof, whatever, that this fever ever does arise spontaneously.
11. That the exceeding speciality of the conditions attaching to the reproduction of the specific poison in the living body itself, as well as the facts relating to the geographical distribution, past and present, of this and the other contagious fevers, constitutes evidence as strong as such evidence can ever be, that none of these fevers originate spontaneously, but are propagated solely by the law of continuous succession.

And, lastly—to crown the whole induction, by a practical test—That by destroying the infective power of the intestinal discharges, by strong chemicals, or otherwise, the spread of the fever may be entirely prevented, and that by repeating this process in every fresh case as it arises, the disease may in time be finally extinguished.

In arriving at these conclusions, I would observe:—

That the principal data on which they rest are, to the best of my belief, sure. Where these data consist in events observed by myself, I can vouch for their accuracy; where in events reported by others, I have taken, whenever this was possible, the most conscientious pains to verify them. In addition to this, all the great cardinal facts are distinguished in a peculiar degree by that precision and exactness which fit them alike for scientific statement and severe scientific deduction.

Whether the inferences drawn from the facts be logical, or whether, consistently with the laws of logic, any other inferences can be substituted for them, it is for others than myself to determine.

The whole induction is gradual. There are no great leaps, but the argument is conducted step by step; and I have striven to the utmost throughout to make one step sure before attempting the next.

The theory, in its entirety, is not only simple and harmonious, but it is in strict accordance with what we already know, of a certainty, of other members of the same family group.

Above all, its truth may be tested every day by a practical test, the employment of which can do no harm, and may do incalculable good.

Here I might fitly conclude. With this last step, as all may see,—Science passes into duty.

For we are not dealing here with questions of which the interest is abstract only. We are not discussing the great question of 'The Plurality of Worlds,' or the 'Darwinian Theory'—problems for whose final solution we shall have, and, many will say, we can afford, to wait—but a matter which, take the world over, for every year that passes, is life or death to myriads of men.

At this very hour scores of English homes are the scene of the agonizing anxieties with which recent experience has made the nation familiar. In hundreds, or, if we extend our view to the whole of Europe, in thousands, of cases, these anxieties have been consummated, within the month, by the death of the sufferer.

And all this the work of an ignoble thing, which, if what has gone before be true, may be disarmed of its terrors by the simplest of precautions.

In my introductory remarks I endeavoured to show, by illustrations drawn chiefly from the homes of the poor, how deeply humanity is concerned in the eradication of this fatal pest.

Since those remarks were first written (1859) the extension of its power to persons more conspicuous in rank has succeeded in awakening and directing, in a very striking way, the national attention to it. More than once since that time men or women bearing great historic names have fallen victims to it. Twice it has cast its dark shadow on the Throne. Once it has placed the entire nation in mourning; and once again it has brought the entire nation, on bended knee, to the Throne of Grace in thanksgiving for a happier issue.

That the people of this Kingdom should testify, in this most solemn of ways, their deep sense of the responsibilities they have in this matter is well.

But if they wish to set a seal on the sincerity of their piety, there is—I say it with all humility—a still higher attitude to take.

It is, to spare from this hour no human effort to put under foot this great enemy of man. And let no one suppose that this is a matter in which he has no personal interest. The duty itself we may evade, but we can never be sure of evading the penalties of its neglect. This disease not seldom attacks the rich, but it thrives most among the poor. But by reason of our common humanity we are all, whether rich or poor, more nearly related here than we are apt to think. The members of the great human family are, in fact, bound together by a thousand secret ties, of whose existence the world in general little dreams.

And he that was never yet connected with his poorer neighbour, by deeds of charity or love, may one day find, when it is too late, that he is connected with him by a bond which may bring them both, at once, to a common grave.

Appendix
(Rules for Preventing the Spread of Typhoid Fever, Drawn Up. For Popular Use)

How Typhoid Fever (Otherwise Called Gastric Fever, or Low Fever) May Be Prevented from Spreading

The means by which typhoid fever may be prevented from spreading are very simple, very sure, and their cost next to nothing.

They are founded on the discovery that the poison by which this fever spreads is almost entirely contained in the discharges from the bowels.

These discharges infect: 1. The air of the sick room. 2. The bed and body linen of the patient. 3. The privy and the cesspool; or the drains proceeding from them.

From the privy or drain the poison often soaks into the well, and infects the drinking water. This last, when it happens, is of all forms of fever poisoning the most deadly.

In these various ways the infection proceeding from the bowel discharges often spreads the fever far and wide.

The one great thing to aim at, therefore, is to disinfect these discharges on their very escape from the body, and before they are carried from the sick room.

This may be perfectly done by the use of disinfectants—one of the best is made of green copperas. This substance, which is used by all shoemakers, is very cheap and may be had everywhere. A pound and a half of green copperas to a gallon of water is the proper strength. A teacupful of this liquid put into the night-pan every time before it is used by the patient, renders the bowel discharge perfectly harmless.[66] One part of Calvert's liquid carbolic acid in fifty parts of water is equally efficacious.

To disinfect the bed, and body linen, and bedding generally, chloride of lime, or MacDougall's or Calvert's Powder, is more convenient. These powders should be sprinkled, by means of a common dredger, on soiled spots on the linen, and about the room, to purify the air.

All articles of bed and body linen should be plunged, immediately on their removal from the bed, into a bucket of water containing a tablespoonful of chloride of lime, or MacDougall's or Calvert's Powder, and should be boiled before being washed. A yard of thin, wide gutta percha[67] placed beneath the blanket, under the breech of the patient, by effectually preventing the discharges from soaking into the bed, is a great additional safeguard.

The privy, or closet, and all drains communicating with it, should be flushed twice daily with the green copperas liquid, or with carbolic acid, diluted with water.

In towns and villages where the fever is already prevalent the last rule should be put in force for all houses, whether there be fever in them or not, and for all public drains.

In the event of death, the body should be placed, as soon as possible, in a coffin sprinkled with disinfectants. Early burial is, on all accounts, desirable.

As the hands of those attending on the sick often become unavoidably soiled by the discharges from the bowel, they should be frequently washed.

The sick room should be kept well ventilated day and night.

The greatest possible care should be taken with regard to the drinking water. Where there is the slightest risk of its having become tainted with fever poison, water should be got from a pure source, or should, at least, be boiled before being drunk. Immediately after the illness is over, whether ending in death or in recovery, the dresses worn by the nurses should be washed or destroyed, and the bed and room occupied by the sick should be thoroughly disinfected.

These are golden rules. Where they are neglected the fever may become a deadly scourge; where they are strictly carried out, it seldom spreads beyond the person first attacked.
W. B.[68]

Outbreak of Fever at the Clergy Orphan School, St. John's Wood (*Lancet*, November 15, 1856)

'An outbreak of epidemic disease, in a public establishment containing a large number of inhabitants, must always be regarded as an event of public interest, and demanding the most searching inquiry. It is now a demonstrated law, that for epidemics of this kind to make their appearance, and spread in a community, some local special cause must be at root. It is a public benefit to give the widest publicity to every circumstance connected with the origin and course of epidemics, and, more especially, in the case where they occur in isolated communities like schools, where all the inmates are probably subjected to the same influences, and are under uniform observation; where peculiar facilities for scientific investigations exist; and where we are, therefore, likely to discover valuable facts, capable of useful application to the preservation of the public health. It is an obvious duty of those medical practitioners whose connection with institutions of a public character affords them special opportunities to add to the fund of scientific facts, faithfully to record the history of such outbreaks.

'The leading facts that have transpired are, briefly, as follows: The school is said to have been generally healthy, and the most scrupulous attention to cleanliness is observed. The children reassembled after the holidays on the 2nd September. The first pupil was taken ill about the 14th, with mild diarrhoea, headache, rigors, lassitude, &c. Four other cases occurred within about three weeks. Some cases of diarrhoea occurred. In the beginning of October, within a period of thirty-six hours, nineteen pupils became simultaneously affected, a large proportion complaining of diarrhoea, severe gastric irritation, and abdominal tenderness, but more particularly over the region of the caput caecum coli. Some suffered from intense headache and congestion of the cerebral vessels; four or five had complications of pulmonary congestions; two with pneumonia. About the fifth day a papular rash was diffused over the body. This was observed in all but two cases. It was remarked that all the more violent cases arose within the thirty-six hours alluded to—a close, damp, oppressive state of atmosphere prevailing. The simultaneous seizure of the patients is sufficient to set aside the idea of contagion. Some local cause was, obviously, at work. It appeared that the drains had been under repair during the holidays, and, although it was considered that all source of malaria from this source had ceased, it is highly probable that some unobserved defect had been suffered to remain. We cannot but repeat, that a minute detail of every case, and a full report of the investigation into the sanitary condition of the institution are necessary, not only for the instruction of the public in a question of great moment, but, also, in vindication of the government and administration of the school.'

On the Fever at the Clergy Orphan School, St. John's Wood By William Budd, M.D., Lecturer on the Practice of Physic at the Bristol Medical School. (*Lancet*, December 6, 1856)

'The outbreak of fever at the Clergy Orphan School, of which such a painfully interesting account appeared in the "Lancet," of Nov. 15th, will probably prove to be no mystery if the facts are looked at from the true point of view.

'From the description of the symptoms, as well as from other circumstances to be gathered from the narrative, there can be little doubt that the disease which is spreading among these orphans is the specific fever whose single anatomical character was first shown by Louis to be an equally specific disease of the intestinal follicles—a fever variously known in this country under the names of common continued, typhoid, gastric fever, and so on, but of which intestinal fever would seem to be a fitter designation. Short as the summary is which your notice contains, it includes nearly all the diagnostic marks of this well-known affection. The detection of the characteristic ulcerations in the intestine seems to be all that is needed to set the seal to its identity. A great number of outbreaks of this fever, precisely similar in their leading incidents to that which has just happened at St. John's Wood, have already occurred in schools and other public establishments in this and other countries. Perhaps the most interesting case of the kind which has yet been recorded is that of the fever which committed such havoc in the military school of La Fleche, in France, in 1826. The scientific precision of the details give to this case a more than common value. As the chief amongst them lie in a small compass, it may not be amiss to reproduce them here.

'The fever was already prevalent in the town before it broke out in the school. As in St. John's Wood, it began in the school with a few scattered cases. In the course of the outbreak four of the pupils died. Their bodies were examined with great care, and, in all four, the characteristic ulcerations of the intestine were found. As the disorder soon gave signs of spreading, the governor of the school decided on anticipating the usual vacation, and sending the pupils home. Before, however, this measure could be carried into effect, sixty of their number were seized with the malady. Twenty-nine others took away the seeds of the fever with them, and were laid up by it at their own homes. Of these twenty-nine, Dr. Renon ascertained that as many as eight communicated the disorder to persons who were engaged in attendance upon them. This species of fever has two fundamental characteristics. The first is, that it is an essentially contagious disorder; the second, that by far the most virulent part of the specific poison by which the contagion takes effect is contained in the diarrhoeal discharges which issue from the diseased and *exanthematous* bowel. This, it may be said, is mere assertion; but there are, probably, few truths in medicine which rest on a body of evidence at once so copious, so various, and so decisive, as that which might be cited in proof of this two-fold proposition. So many and such striking proofs of both the facts here asserted have come before myself, that I have looked upon them as being as sure as that itch is contagious, and that small-pox may be inoculated. When these facts are kept steadily in view, the interpretation of such events as those which occurred at La Flèche becomes to the last degree simple.

'The first case in the series man, either be casual and imported, or may be due to the local rekindling, through atmospheric or other changes, of poison which had remained as the dormant legacy of some former similar attack. In either case, in the usual course of things, diarrhoea comes on in the infected subject; and the next thing that happens is that the discharges from the bowels, which are usually at once copious, numerous, and liquid, are thrown into the water closet or privy. In this way, the drains, or system of drains, belonging to the place become at once saturated with the specific poison in its most concentrated and virulent form. This once occurring, the poison may give the fever to the healthy inmates in one of three ways—either by percolating into the well which supplies the drinking water; by issuing through defects in the sewer into the air of the inhabited area; or, still more directly, by exhaling from the aperture of some ill-trapped water closet or privy, which is at once the receptacle of the discharges from the sick and the daily resort of the healthy. Assuming the identity of the disease to be determined, it may safely be prophesied that the true key to the events which have lately occurred in this orphan asylum will be found in some of these simple relations. I have myself seen very striking instances, on a large scale, of all three of these modes of communication. A very memorable one, of the propagation of this fever by the bursting of a cesspool into a well, occurred in this place in 1848.

'It is essential to a true view of the phenomena to understand that when the poison issues into the air (often, it may be, into a common day-room or dormitory), the atmosphere generated is *immeasurably more infectious than that which immediately surrounds the fever patients.* The sewer may be looked upon, in fact, as a *direct continuation of the diseased intestine;* with this important difference, however, that instead of being a narrow tube, which, except when the bowels act, is hermetically sealed, it is a large chamber, whose expanded surface, when the construction is imperfect, is either slowly distilling the infection into the soil, or constantly exhaling it in large volumes into the surrounding air. As this species of fever, like all other contagious fevers, has what is called a period of incubation, it necessarily happens that when the first case is an imported one, a considerable interval elapses before the development of the group of cases which may chance to spring from it. From a large number of facts, bearing on the point, which have fallen under my own observation, I have been led to the conclusion, that this period ranges from ten to fourteen days.[69] There is reason to believe, however that its duration varies considerably, partly with the nature of the medium through which the specific poison finds admission to the living body, partly by reason of conditions it meets with there, and still more, as I have been led to think, in virtue of the greater or less intensity of the metamorphosis in which the poison itself may be at the moment of its reception. The simultaneous seizure of a large number of inmates in an establishment like this, at the interval of a week or two after the occurrence of the first cases, so far from negativing the idea of contagion as the writer of your notice supposes, is precisely what we should expect to witness under that mode of propagation. It is the exact counterpart, in fact, with the Difference due to the different nature of the disorders, of what has been observed a hundred times before in schools, in the case of measles, scarlet fever, and, in former times, of small-pox also.

'I may add, in conclusion, that I do not offer these remarks with the view of prejudging the inquiry at St. John's Wood. My principal object in writing them is to avail myself of the opportunity they afford of earnestly recommending the adoption of some very simple measures which I have long been in the practice of employing for checking the spread of this fever, and by whose means, *provided they are thoroughly and effectually carried out*, I believe the recurrence of such calamities may be entirely prevented. These measures are founded on the power of chemical agents to destroy the contagious properties of contagious poisons. If it be certain that the intestinal discharges in this fever are the principal means of propagating the disease, it is no less certain, that by subjecting the discharges, on their issue from the body, to the action of powerful disinfectants, they may be entirely deprived of this property. An actual instance of the application of these preventives will illustrate the mode of their employment better than any general statement. In the month of June, 1853, I was consulted by the head of a large retail establishment in this city, in consequence of the occurrence of several cases of this fever among his hands. Three cases had already occurred, and a fourth patient was now lying ill of the fever, and in a most dangerous state. The idea of propagation by contagion was supposed to be out of the question, because each one of the four who had fallen sick was separated from the other intimates of the house the moment the first signs of disorder appeared. It was, however, a very significant fact that these four were all women. There had been severe diarrhoea in all the cases, and, on inquiry, I found, as I had anticipated, that the diarrhoeal discharges had all been thrown down the water closet appropriated to the female part of the establishment. In the water closet itself, at the time of my first visit, there were three vessels containing the three last discharges from the patients' bowels, which, in accordance with a too common practice, had been placed there without being subjected to disinfecting measures, to await the inspection of the medium men. Some linen, stained with these discharges, which had just been removed from the sick-bed, lay in the vestibule. Under these circumstances, the following measures were suggested—

'1. That for the future all the discharges from the fever patient should be received on their issue from the body into vessels containing a concentrated solution of chloride of zinc.

'2. That all tainted bed or body linen should, immediately on its removal, be placed in water, strongly impregnated with the same agent.

'3. That the water closet should be flooded several times a day with it, and that some chloride of lime should be placed there, to serve as a Source of chlorine in the gaseous form.

'And, lastly, and by way of further precaution, that so long as the fever lasted, the water closet should be used exclusively as a receptacle for the discharges from the sick.

'These precautions were carried out to the letter, and the result was that no other case of fever occurred among the remaining twelve or fourteen young women who lived in the establishment.

'I may add, that since I have adopted this method of prevention, I have only met with one instance, where it was used from the first, in which the disease has spread beyond the single person first attacked.[70] Before I adopted it, it was no uncommon thing for me to see several members of a family take the disorder one after another, even in airy and well-appointed houses.

'It may, perhaps, be alleged that the measures here recommended are already in very general use happily, the case is one in which the natural instincts suggest what science prescribes, and in which measures adopted to prevent noisome smells accomplish a higher purpose. It is not the only case that might be sited in which the nose is wiser than the intellect that it serves. But measures of this kind, if they are carried out at all, are only carried out in the houses of the rich, and, even in them, as far as my observation goes, they are never executed with the completeness which an insight into the real exigencies of the case requires.

'Amongst the poor such refinements are never thought of, and when this fever breaks out in a poor family the discharges from the bowels are thrown without preparation into the common privy, or, as I have seen a hundred times in rural districts, are cast upon the dungheap, or into the open gutter. From this point, following the line of watershed, this perilous stuff often makes its way to considerable distances, where, appearing now under the guise of an epidemic miasm, which entirely masks its true origin, it may carry the seeds of fresh disease and death into many an unsuspecting household. If the practice were universal of depriving this stuff of its infectious properties before it is let loose upon the world, I believe it is not too much to say, that the lives of a large proportion of the many thousands who die annually of this fatal disease in the British Isles would be saved by the measure, and a corresponding amount of sickness be prevented.'

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CHAPTER 15

FLORENCE NIGHTINGALE
(1820–1910)

Her statistics were more than a study, they were indeed her [Nightingale's] religion.

—Karl Pearson, *Life, Letters and Labours for Francis Galton*, 1924

Florence nightingale, the second daughter of her wealthy parents William Edward and Frances Nightingale, was born on May 12, 1820, in Florence, Italy. The family lived in Lea Hurst, Derbyshire, during the summer, moving to their home in Embley, Hampshire, for the remainder of the year. Florence and her older sister, Parthenope, were homeschooled by their Cambridge University–educated father. Parthenope excelled at painting and needlework, whereas Florence was academically gifted, especially in statistics. In 1837, Florence was in the garden at Embly when she had a life-altering experience, one she explained as "a calling from God." After that experience, Florence began making visits to the homes of the sick, but her desire to become a nurse was resisted as her parents felt it was not a "suitable profession" for a highly educated woman.

Politician and poet Richard Monckton Milnes, First Baron Houghton, courted young Florence, but she believed that marriage would interfere with her plans for nursing and rejected his advances. While traveling in Rome in 1847, she met and formed an attraction for Sidney Herbert, a brilliant politician who served as secretary at war. Herbert was, unfortunately, a married man, but he supported Florence in her calling to nursing, and the two remained lifelong friends. While touring Europe with family friends Charles and Selina Bracebridge, the threesome visited a hospital at Kaiserswerth, near Düsseldorf, Germany, in 1850. The next year, Florence returned to Kaiserswerth to take three or four months (this is variously reported) of nursing training. When she returned to London, Herbert aided her in obtaining a supervisory nursing position at the Establishment for Gentlewomen During Illness in 1853.

In March 1854, Britain, France, and Turkey declared war on Russia. While the allies defeated the Russians in battle, *The Times* critically reported on the poor status of the British medical facilities that cared for the wounded. Sidney Herbert was again serving as minister at war and appointed Nightingale to oversee the introduction of female nurses into British military hospitals in Turkey. Nightingale arrived at the Barrack Hospital in Scutari (modern-day Üsküdar in Istanbul) with 38 nurses on November 4, 1854. She set new standards for patient care, wrote letters home on behalf of the soldiers, acted as banker, and introduced reading rooms to the hospital. Her nurses thoroughly cleaned the hospital and all the equipment, yet the death rate did not drop. Despite their efforts, 10 times more soldiers died that first winter from illnesses such as typhus, typhoid, cholera, and dysentery than from battle wounds.

Parliament sent a British Sanitary Commission to flush out the sewers and improve ventilation at Scutari six months after the nurses first arrived. Only then did the death rates begin to fall. This proved to Nightingale that overcrowding, defective sewers, and lack of ventilation were the cause of the high mortality, not poor nursing care. This experience with sanitary science was eye-opening for Nightingale, and she returned to Britain to collect the evidence that most soldiers in hospital were killed by poor living conditions rather than their war wounds.

Nightingale made friends with statisticians Chadwick and Farr, eliciting their help as she used mortality statistics to make an argument for the need to improve the sanitary design of hospitals. She argued for limiting the spread of infection in hospitals through cleanliness and air circulation, through the use of a "pavilion plan" to limit cross-contamination. Her recommendations for hospital construction were widely instituted not only in Britain but across Europe and the United States.

In 1860, Nightingale established the Nightingale Training School for nurses at St. Thomas' Hospital. Once her students completed their nursing training, Nightingale gave them her *Notes on Nursing* book and invited them to tea. Her nurses staffed many of the hospitals in Britain and abroad, and her training style focusing on the patients' needs was copied in most nursing schools.

In 1865 Florence moved to 10 South Street, Mayfair, in the West End of London. She became bedridden for most of her remaining years, barring her mother and sister from her bedroom. (Some sources suggest she was suffering from post-traumatic stress syndrome from her experiences in the Crimea; others suggest she had bipolar disorder or chronic fatigue syndrome.) Despite her confinement, Nightingale continued to advocate for improved hospital conditions and improved standards for nurses. She wrote a more than 1,000-page report of the Royal Commission on the Health of the Army, of which Sidney Herbert was chairman. While Nightingale could not serve as a commissioner because she was a woman, she was clearly the influence that drove the commission's recommendations.

Over the course of her lifetime, Nightingale published about 200 books, reports, and pamphlets, leading Queen Victoria to award her the Royal Red Cross in 1883. She died at home on August 13, 1910, at the age of 90 years. Nightingale is buried at St. Margaret's, near her parents' home in Embley.

A Note on the Text

Nightingale wrote in two styles, passionate and statistical. *Notes on Nursing* is a passionate work, showing Nightingale's love of the field and her ability to instruct women on ways to improve their nursing skills. The work was seminal in making nursing a respectable profession for women and served a role in the Civil War by inspiring women to serve as nurses in field hospitals. As it is still in print and widely available today, we do not provide it here. Instead, we offer Nightingale's Sanitary Condition of *Hospitals and Hospital Construction*, the work that showcases Nightingale's statistical ability, the strength that made her the first woman to be elected a fellow of the Statistical Society and an honorary member of the American Statistical Association. Indeed, her statistical work was so powerful that it inspired the Union government to approach Nightingale for advice in organizing field medicine during the Civil War. Nightingale's testimony from *Notes on Hospitals* set the standard for hospital construction until building technology improved sufficiently to allow for mechanical fresh air circulation and until the ward system was rejected, replaced by a demand for smaller units with a central nursing station.

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Sanitary Condition of Hospitals and Hospital Construction (1859)

Part I

Feeling very desirous of contributing whatever aid I can to improvement in Hospital construction and administration—especially at this time, when several new hospitals are being built—it has occurred to me to transmit a few notes on defects which have come under my own observation in an extended experience of these institutions.

No one, I think who brings ordinary powers of observation to bear on the sick and maimed can fail to observe a remarkable difference in the aspect of cases, in their duration and in their termination in different hospitals. To the superficial observer there are two things apparent—the disease and the remedial treatment, medical or surgical. It requires a considerable amount of experience, in hospitals of various constructions and varied administrations, to go beyond this, and to be able to perceive that conditions arising out of these have a very powerful effect indeed upon the ultimate issue of cases which pass through the wards.

It is sometimes asserted that there is no such striking difference in the mortality of different hospitals as one would be led to infer from their great apparent difference in sanitary condition. There is, undoubtedly, some difficulty in arriving at correct statistical comparison to exhibit this. For, in the first place, different hospitals receive very different proportions of the same class of diseases. The ages in one hospital may differ considerably from the ages in another. And the state of the cases on admission may differ very much in each hospital. These elements, no doubt, affect considerably the results of treatment, altogether apart from the sanitary state of hospitals.

In the next place accurate hospital statistics are much more rare than is generally imagined, and at the best they only give the mortality which has taken place *in* the hospitals, and take not cognizance of those cases which are discharged in a hopeless condition, to a much greater extent from some hospitals than from others.

We have known incurable cases discharged from one hospital, to which the deaths ought to have been accounted, and received into another hospital, to die there in a day or two after admission.

Again, the sanitary state of any hospital ought not to be inferred solely from the greater or less mortality. If the function of a hospital were to kill the sick, statistical comparisons of this nature would be admissible. As, however, its proper function is to restore the sick to health as speedily as possible, the elements which really give information as to whether this is done or not, are those which show the proportion of sick restored to health, and the average time which has been required for this object; a hospital which restored all its sick to health after an overage of six months' treatment, could not be considered as by any means so healthy as a hospital which returned all its sick recovered in as many weeks. The proportion of recoveries, the proportion of deaths, and the average time in hospital must all be taken into account in discussions of this nature, as well as the character of the cases and the proportion of different ages among the sick.

Hospital mortality statistics[1] give little information on the point, because there are elements in existence of which such statistics take no cognizance. In one set of metropolitan hospitals, for example, I find the mortality about two and a-half per cent, upon the cases treated, while in other metropolitan hospitals the deaths reach from about twelve to sixteen per cent. To judge by the mortality in these cases would be most fallacious. Because in the first class of hospitals every ailment, however slight, constitutes a title to hospital admission, while, in the latter class of hospitals, special diseases only, at all times accompanied by a high rate of mortality, are admitted. Hence the duration of the cases admitted, and the general course and aspect of disease afford important criteria whereby to judge of the healthiness or unhealthiness of any hospital in addition to that afforded by the mortality statistics. Besides, careful observers are now generally convinced that the origin and spread of fever in a hospital, or the appearance and spread of hospital gangrene, erysipelas and pyaemia generally, are much better tests of the defective sanitary state of a hospital than its mortality returns. But I would go further, and state that to the experienced eye of a careful observing nurse, the daily, I had almost said hourly, changes which take place in patients, and which changes rarely come under the cognizance of the periodical medical visitor, afford a still more important class of data, from which to judge of the general adaptation of a hospital for the reception and treatment of sick. One insensibly allies together restlessness, languor, feverishness, and general *malaise,* with closeness of wards, defective ventilation, defective structure, bad architectural and administrative arrangements, until it is impossible to resist the conviction that the sick are suffering from something quite other than the disease inscribed on their bed-ticket—and the inquiry insensibly arises in the mind, what can be the cause? To this query many years' experience of hospitals in various countries and climates enables me to answer explicitly as the result of my own observation, that, even admitting to the full extent the great value of the hospital improvements of recent years, a vast deal of the suffering, and some at least of the mortality in these establishments, is avoidable.

What, then, are those defects to which such results are to be attributed?

I should state at once that to original defects in the sites and plans of hospitals, and to deficient ventilation and overcrowding accompanying such defects, is to be attributed a large proportion of the evil I have mentioned.

The facts flow almost of necessity from ascertained sanitary experience. But it is not often, excepting perhaps in the case of intelligent house surgeons, that the whole process whereby the sick, who ought to have had rapid recoveries, are retained week after week, or perhaps month after month, in hospital, is continuously observed. I have known a case of slight fever received into hospital, the fever pass [*sic*] off in less than a week, and yet the patient, from the foul state of the wards, not restored to health at the end of eight weeks.

The defects to which such occurrences are mainly to be attributed are four:—

1. The agglomeration of a large number of sick under the same roof.
2. Deficiency of space.
3. Deficiency of ventilation.
4. Deficiency of light.

These are the four radical defects in hospital construction.

But on the very threshold of the subject we shall probably be told that not to these defects, but to 'contagion' and 'infection,' is much of the unhealthy condition of some hospitals attributable, at least so far as concerns the occurrence of zymotic diseases. On the very threshold, therefore, we are obliged to make a digression in order to discuss the meaning of these two familiar words, and to lay these specters which have terrified almost all ages and nations.

This is the more necessary, because on the exact influence exercised by these two presumed causes of hospital sickness and mortality depends to a great degree the possibility of our introducing efficient hospital attendance and nursing. Unfortunately, both nurses[2] and medical men, as well as medical students, have died of zymotic diseases prevailing in hospitals. It is an all-important question to decide whether the propagation of such diseases is inevitable or preventable. If the former, then the whole question must be considered as to whether hospitals necessarily attended with results so fatal should exist at all. If the latter, then it is our duty to prevent their propagation.

The idea of 'contagion,' as explaining the spread of disease, appears to have been adopted at a time when, from the neglect of sanitary arrangements, epidemics attacked whole masses of people, and when men had ceased to consider that nature had any laws for her guidance. Beginning with the poets and historians, the word finally made its way into medical nomenclature,[3] where it has remained ever since, affording to certain classes of minds, chiefly in the southern and less educated parts of Europe, a satisfactory explanation for pestilence and an adequate excuse for non-exertion to prevent its recurrence.

And now, what does 'contagion' mean? It implies the communication of disease from person to person by contact. It pre-supposes the existence of certain germs like the sporules of fungi, which can be bottled up and conveyed any distance attached to clothing, to merchandize [*sic*], especially to woolen stuffs, for which it is supposed to have a particular affection, and to feathers, which of all articles it especially loves—so much so, that, according to quarantine laws, a live goose may be safely introduced from a plague country; but if it happen to be eaten on the voyage, its feathers cannot be admitted without danger to the entire community. There is no end to the absurdities connected with this doctrine. Suffice it to say, that in the ordinary sense of the work, there is no proof, such as would be admitted in any scientific inquiry, that there is any such thing as 'contagion.'

There are two or three diseases in which there is a specific virus, which can be seen, tasted, smelt, and analysed, and which in certain constitutions propagates the original disease by inoculation—such as small-pox, cow-pox, &c. But these are not 'contagious' in the sense supposed.[4]

The word 'infection,' which is often confounded with 'contagion,' expresses a fact, and does not involve a hypothesis. But just as there is no such thing as 'contagion,' there is no such thing as *inevitable* 'infection.' Infection acts through the air. Poison the air breathed by individuals and there is infection. Shut up 150 healthy people in a Black-hole of Calcutta, and in twenty-four hours an infection is produced so intense that it will, in that time, have destroyed nearly the whole of the inmates. Sick people are more susceptible than healthy people; and if they be shut up without sufficient space and sufficient fresh air, there will be produced not only fever, but erysipelas, pyaemia, and the usual tribe of hospital-generated epidemic diseases.

Again, if we have a fever hospital with over-crowded, badly-ventilated wards, we are quite certain to have the air become so infected as to poison the blood not only of the sick, so as to increase their mortality, but also of the medical attendants and nurses, so that they also shall become subjects of fever.

It will be seen at a glance, that in every such case and in every such example, the 'infection' is not inevitable, but simply the result of carelessness and ignorance. As soon as this practical view of the subject is admitted and acted upon, we shall cease to hear of hospital contagions.

In certain hospitals it has been the custom to set apart wards for what are called 'infectious' diseases, but in reality there ought to be no diseases so considered. With proper sanitary precautions, diseases reputed to be the most 'infectious' may be treated in wards among other sick without danger. Without proper sanitary arrangements, a number of healthy people may be congregated together so as to become subject to the worst horrors of 'infection.'

No stronger condemnation of any hospital or ward could be pronounced than the simple fact that any zymotic disease has originated in it, or that such diseases have attacked other patients than those brought in with them. And there can be no stronger condemnation of any town than the outbreak of fatal epidemics in it. Infection, and incapable management, or bad construction, are in hospitals as well as in towns, convertible terms.

It was necessary to say thus much to show to what hospital diseases are *not* necessarily due. To the following defects in site, construction, and management, as we think, they are mainly to be attributed.

1. *The agglomeration of a large number of sick under one roof.*—It is a well-established fact that, other things being equal, the amount of sickness and mortality on different areas bears a ratio to the degree of density of the population.

Why should undue agglomeration of sick be any exception to this law? Is it not rather to be expected that, the constitutions of sick people being more susceptible than those of healthy people, they should suffer more from this cause?

But if anything were wanting in confirmation of this fact, it would be the enormous mortality in the hospitals which contained perhaps the largest number of sick ever at one time under the same roof, *viz.*, those at Scutari. The largest of these too famous hospitals had at one time 2500 sick and wounded under its roof, and it has happened that of Scutari patients two out of every five have died. In the hospital tents of the Crimea, although the sick were almost without shelter, without blankets, without proper food or medicines, the mortality was not above one-half what it was at Scutari. Nor was it even so high as this in the small Balaclava General Hospital, while in the huts of the Castle Hospital, on the heights above Balaclava, at a subsequent period, the mortality among the wounded did not reach three per cent. It is not to this, however, that we appear, as the only proof of the danger of surface over-crowding. It is to the fact of 80 cases of hospital gangrene having been recorded during one month at Scutari (and many, many more, passed unrecorded); to the fact that, out of 44 secondary amputations of the lower extremities consecutively performed, 36 died; and to the cases of fever which broke out in the hospital, not by tens but by hundreds.

All experience tells the same tale, both among sick and well. Men will have a high rate of mortality in large barracks, a low one in separate huts, even with a much less amount of cubic space.[5]

The example which France and Belgium have lately set us of separating their hospitals into a number of distinct pavilions, containing generally not more than 100 sick each, should be elsewhere imitated. It may be useful, by way of illustrating good and bad hospital structure, to annex plans of the newest civil and military hospitals constructed in Paris, in contrast with plans of the newest civil and military hospitals constructed in England.

The Lariboisière as the civil hospital, the Vincennes as a military one, exhibit the latest and the best specimens of hospital construction in Paris.

King's College as a civil hospital, and Netley as a military one, are among the latest—we would say the best—plans of hospital construction in England.

The Lariboisière, as will be seen from the plan, contains 600 beds, under six different roofs.

In the Vincennes plan the pavilions are end to end, two and a-half to each wing, and contain about 600 beds in four pavilions and two half-pavilions.

Netley Hospital is to contain 1000 sick and invalids, under two roofs.

2. *Deficiency of Space*.—Wherever cubic space is deficient, ventilation is bad. Cubic space and ventilation will therefore go hand in hand. The law holds good with regard to hospitals, barracks, and all inhabited places. Deficiency of cubic space is confounded by unskillful sanitary statisticians with surface over-crowding in towns, although the things are quite different, and lead to different results. In a recent paper it has been argued that because the statistics of disease in towns of different densities do not show so large a proportionate mortality from consumption as takes place in the army, *therefore* the allegation that the army mortality is caused by overcrowding and bad ventilation is incorrect. We happen to know that deficient external ventilation and over-crowding in barracks, as regards cubic space, stand as follows:—

The cavalry barracks, as a whole, are the least crowded, and have the freest external movement of air. Next come the infantry; and the most crowded and the least ventilated externally are the Guards' barracks; so that the mortality from consumption which follows the same order of increase in the different arms augments with increase of crowding, and difficulty of ventilation.

If over-crowding or its concomitant, bad ventilation, among healthy people, generates disease, it does so to a far greater extent among the sick in hospitals. In civil hospitals the amount of cubic space varies between 600 and 2000 cubic feet per bed. In some military hospitals it is under 300; and from 700 to 800 appear to be considered a somewhat extravagant allowance. The army regulation as to cubic space in hospital is over-crowding. At Scutari, at one time, not even half the regulation-space was given; and the great over-crowding consequent thereupon was one element in the disastrous result which followed. Any one in the habit of examining hospitals with different relative amounts of cubic space cannot fail to have been struck with the very different appearance of the sick, and with the different state of the ward atmosphere. It is impossible to ventilate a ward in a brick or stone hospital by natural means, when the cubic space is less than a certain amount. Crowded wards are, in fact, offensive, with all the windows open.

In the country less cubic space is essential than in towns. In detached huts or pavilions, especially if they be but one story high, less cubic space is necessary than where numbers are massed together.

Under all circumstances, however, the progress of the cases (in solidly-built hospitals) will betray any curtailment of space much below 1500 cubic feet. In Paris 1700, and in London 2000 and even 2500 cubic feet are now thought advisable.

The master of some large works in London lately mentioned the following fact:—He was in the habit of sending those of his workmen who met with accidents to two different metropolitan hospitals. In one they recovered quickly: in the other they were frequently attacked with erysipelas, and some cases were fatal. On inquiry it appeared that in the former hospital a larger amount of cubic space was allowed than in the latter, which is also so deficient in external ventilation and in construction, that nothing but artificial ventilation could effectively change its atmosphere.

It is no less important to have a sufficient surface area between the adjoining and opposite beds. Piling cubic space above the patient is not all that is wanted. In the lofty corridors of Scutari I have seen two long rows of opposite beds with scarcely three feet from foot to foot. Certainly it cannot be thought too much, under any circumstances, to give to each bed a territory to itself of at least eight feet wide by twelve feet long.

3. *Deficiency of Ventilation*.—The want of fresh air may be detected in the appearance of patients sooner than any other want. No care or luxury will compensate indeed for its absence. Unless the air *within* the ward can be kept as fresh as it is *without*, the patients had better be away. Except in a few cases well known to physicians the danger of admitting fresh air directly is very much exaggerated. Patients in bed are not peculiarly inclined to catch cold,[6] and in England, where fuel is cheap, somebody is indeed to blame, if the ward cannot be kept warm enough, and if the patients cannot have bed-clothing enough, for as much air to be admitted from without as suffices to keep the ward fresh. *No* artificial ventilation will do this. Although in badly-constructed hospitals, or in countries where fuel is dear, and the winter very cold, artificial ventilation may be necessary, it never can compensate for the want of the open window. The ward is never fresh, and in the best hospitals at Paris, artificially ventilated,

it will be found that, till the windows are opened in the morning, the air is close. Natural ventilation, or that by open windows and open fireplaces, is the only efficient means for procuring the life-spring of the sick—fresh air. But to obtain this the ward should be at least sixteen feet high, and the distance between the opposite windows not more than thirty feet. The amount of fresh air required for ventilation has been hitherto very much underrated, because it has been assumed that the quantity of carbonic acid produced during respiration was the chief noxious gas to be carried off. The total amount of this gas produced by an adult in twenty-four hours is about 40,000 cubic inches, which, in a barrack-room, say, containing sixteen men, would give 370 cubic feet *per diem*. Allowing eight hours for the night occupation of such a room, when the doors and windows may be supposed to be shut, the product of carbonic acid would be 123 cubic feet, or about fifteen and a-half cubic feet per hour. This large quantity, if not speedily carried away, would undoubtedly be injurious to health; but there are other gaseous poisons produced with the carbonic acid which have still greater power to injure. Every adult exhales by the lungs and skin forth-eight ounces, or three pints of water in twenty-four hours. Sixteen men in a room would therefore exhale in eight hours sixteen pints of water, and 123 cubic feet of carbonic acid into the atmosphere of the room. With the watery vapour there is also exhaled a large quantity of organic matter, ready to enter into the putrefactive condition. This is especially the case during the hours of sleep, and as it is a vital law that all excretions are injurious to health if reintroduced into the system, it is easy to understand how the breathing of damp foul air of this kind, and the consequent re-introduction of excrementitious [*sic*] matter into the blood through the function of respiration will tend to produce disease.

If this be so for the well, how much more will it be so for the sick?—for the sick, the exhalations from whom are always highly morbid and dangerous, as they are one of nature's methods of eliminating noxious matter from the body, in order that it may recover health.

One would think that the first and last idea in constructing hospitals would be to contrive such means of ventilation as would be perpetually and instantly carrying off these morbid emanations. One would think that it would be the first thing taught to the attendants to manage such means of ventilation. Often however, it is *not even* the *last* thing taught to them.

A much larger mass of air is required to dilute and carry away these emanations than is generally supposed, and the whole art of ventilation resolves itself into applying in any specific case the best method of renewing the air sufficiently without producing draughts, or occasioning excessive varieties in temperature. Trifling varieties are rather beneficial than otherwise in most cases. A cooler atmosphere at night acts like a tonic.

4. *Deficiency of Light.*—What is the proportionate influence of the four defects enumerated in delaying recovery I am not competent to determine.

Second only to fresh air, however, I should be inclined to rank light in importance for the sick. Direct sunlight, not only daylight, is necessary for speedy recovery, except, perhaps, in certain ophthalmic and a small number of other cases. Instances could be given, almost endless, where, in dark wards or in wards with a northern aspect, even when thoroughly warmed, or in wards with borrowed light, even when thoroughly ventilated, the sick could not by any means be made speedily to recover. The effect of light on health and disease has been ably discussed in an article on light in the August number, 1858, of the 'North British Review.' Its importance has been long recognized in the medical profession, as may be learned from the writings of Sir Andrew Wylie, Dr. Milne Edwards, and Mr. Ward. Dark barrack-rooms, and barrack-rooms with northern aspects, will furnish a larger amount of sickness than light and sunny rooms.

Among kindred effects of light I may mention, from experience, as quite perceptible in promoting recovery, the being able to see out of a window, instead of looking against a dead wall; the bright colours of flowers; the being able to read in bed by the light of a window close to a bed-head. It is generally said that the effect is upon the mind. Perhaps so; but it is no less so upon the body on that account.

All hospital buildings in this climate should be erected so that as great a surface as possible should receive direct sunlight—a rule which has been observed in several of our best hospitals, but, I am sorry to say, passed over in some of those most recently-constructed. Window-blinds can always moderate the light of a light ward; but the gloom of a dark ward is irremediable.

The axis of a ward should be as nearly as possible north and south; the windows on both sides, so that the sun shall shine in (from the time he rises till the time he sets) at one side or the other. There should be a window to at least every two beds, as is the case now in our best hospitals. Some foreign hospitals, in countries where the light is far more intense than in England, give one window to every bed. The window-space should be one-third of the wall-space. The windows should reach from two or three feet of the floor to one foot of the ceiling. The escape of heat may be diminished by plate or double glass. But while we can generate warmth, we cannot generate daylight, or the purifying and curative effect of the sun's rays.

Part II

Considering, then, that these conditions essential to the health of hospitals are principally these—

1.) Air. 2.) Light. 3.) Ample Space. 4.) Subdivision of Sick into Separate Buildings or Pavilions—let us examine the causes in the usual ward construction which prevent us from obtaining these and other necessary conditions. The principal causes are as follow, *viz.*:—

1. Defective Means of Natural Ventilation and Warming.
2. Defective Height of Wards.
3. Excessive Width of Wards between the Opposite Windows.
4. Arranging the Beds along the Dead Walls.
5. Having more than two Rows of Beds between the Opposite Windows.
6. Having Windows only on one Side, or having a closed Corridor connecting the Wards.
7. Using Absorbent Materials for Walls and Ceilings, and Washing Floors of hospitals.
8. Defective Condition of Waterclosets.
9. Defective Ward Furniture.
10. Defective Accommodation for Nurses and Discipline.
11. Defective Hospital Kitchens.
12. Defective Hospital Laundries.
13. Selection of Bad Sites and Bad Local Climates for Hospitals.
14. Erecting Hospitals in Towns.
15. Defects of Sewerage.
16. Construction of Hospitals without Free Circulation of External Air.

1. *Defective Means of Ventilation and Warming.*—When the question of ventilation first assumed a practical shape in this country, it was supposed that 600 cubic feet of air per hour were sufficient for a healthy adult, in a room where a number of people are congregated together. Subsequent experience, however, has shown that this is by no means enough. As much as 1000 cubic feet have been found insufficient to keep the air free from closeness and smell; and it is highly probable that the actual quantity required will ultimately be found to be at least 1500 cubic feet per hour per man.

In sick wards we have more positive experience as to the quantity of air required to keep them sweet and healthy. It has been found in certain Parisian hospitals, in which the ventilating arrangements were deficient, that pyæmia and hospital gangrene had appeared among the patients. These diseases disappeared, on the introduction of ventilating arrangements, whereby 2500 cubic feet of air per bed per hour were supplied to the wards. Notwithstanding this large quantity, however, the ward-atmosphere was found not to be sufficiently pure. In other wards the quantity of air was increased to as much as 4000 or 5000 cubic feet per bed per hour—an amount which keeps the wards perfectly sweet. But again we say, do not trust the artificial means; without natural ventilation the air will never be *fresh*.

In this country, have no other than the open fireplace. It is the safest warmer and ventilator. Heated air from metal surfaces is especially to be avoided. It seems likely that we shall soon be enabled to have open fireplaces in the middle of wards, the draught being carried under the floor. It is obvious that fireplaces in the side walls are in the wrong place. There is great loss and unequal distribution of heat in consequence.

2. *Defective Height of Wards*.—It is not possible to ventilate sufficiently a ward of ten or twelve feet high. And again, it is not possible to ventilate a ward where there is a great height above the windows. A ward of thirty beds can be well ventilated with a height of about sixteen or seventeen feet, provided the windows reach to within one foot of the ceiling. Otherwise, the top of the ward becomes a reservoir for foul air.

3. *Too great Width of Wards between the Opposite Windows*.—It does not appear as if the air could be thoroughly changed, if a distance of more than thirty feet intervenes between the opposite windows: if, in other words, the ward is more than thirty feet wide. This is the true starting-point from which to determine the size of your ward, and the number of beds you will have in it. If you make your length too great in proportion to this width, your ward becomes a tunnel—a form fatal to good ventilation. This was the case with the great corridor wards at Scutari.

If, on the other hand, you make your wards too short in proportion to this width, you multiply corners in a greater ratio than you multiply sick. And direct experiment has shown that the movement of the air in the centre of a ward is three to four times as great as it is at the corners. The movement of the air in a hospital ward should always be slightly perceptible over the face and hands, and yet there should be no draughts.

4. *Arranging the Beds along the Dead Walls*.—This deprives the patient of the amount of light and air necessary to his recovery, and has, besides, the disadvantage that when the windows are opened the effluvia must blow over all the intervening beds before escaping. This arrangement is to be seen at Portsmouth Military Hospital, Chatham Garrison Hospital, in the new part of the Edinburgh Infirmary, and is proposed at Netley Hospital.

5. *Having more than two Rows of Beds between the Opposite Windows*.—In the double wards, or wards back to back, of the new part of Guy's, of King's College, and of the Fever Hospital, this arrangement is seen. It is objectionable on every account. These double wards are from twelve to nearly twenty feet wider than they ought to be between the opposite windows for thorough ventilation. The partition down the middle with

apertures makes matters rather worse; complaint has been made that it beats down the draught on the heads of the inner rows of patients. It also prevents the head nurse from having that view of her whole ward at once, which she ought to have for proper care of it. The only hospital in which this arrangement of four rows of beds could be comparatively unobjectionable, would be in a one-storied hut hospital, ventilated through the ceiling, like that of Dr. Parkes, at Renkioi.[7] But his were magnificent huts, and the partition was little more than a bulkhead. In the ordinary huts of the Sardinian camp-hospitals at Balaclava I have seen this arrangement produce pernicious effects.

6. *Having Windows only on one Side, or having a closed Corridor connecting the Wards*.—As it is a necessity of hospital construction that every ward ought to have direct communication with the external air by means of a sufficient number of windows on its opposite sides, it follows that to have a dead wall on one side, or to cover one of the sides by a corridor, is directly to interfere with the natural ventilation of the ward. To join all the ward doors and windows on one side by means of a corridor is much more objectionable than even to have a dead wall, because the foul air of all the wards must necessarily pass into the corridor; and hence, without extraordinary precautions, such are not usually nor likely to be bestowed on such matters, these corridors are the certain means of engendering a hospital atmosphere. If any one had wished to see the corridor plan in all its horrors, Scutari would have shown them to him on a colossal scale. But the evils connected with corridors may be seen on a smaller scale in almost every hospital in London, and Netley also is to have its corridor.

This country is much indebted to Mr. Roberton, of Manchester, to the Medical Staff of the Middlesex Hospital, and to the Army Sanitary Commission for their advocacy of the pavilion system of hospital construction, in opposition to the corridor system, as also for their enlightened labours in the cause of good hospital construction generally.

7. *Using Absorbent Materials for Walls and Ceilings, and Washing Floors of hospitals*.—The amount of organic matter given off by respiration and in other ways from the sick is such that the floors, walls, and ceilings of hospital wards—if not of impervious materials, become dangerous absorbents.

The boards are in time saturated with organic matter, and only require moisture to give off noxious effluvia. When the floors are being washed, the smell of something quite other than soap and water is perfectly perceptible, and there cannot be a doubt that washing floors is one cause of erysipelas, &c., in some hospitals.

In Scutari, where the wards were overcrowded, the cases offensive, and the floors ill-laid, rotten and dirty, the accumulated saturations of weeks and months were such that the floors could not be scoured without poisoning the patients.

There is no remedy for this but filling up the grain of the wood (which ought to be oak) with bees-wax and turpentine, like the French *parquet*, or oiling and *lackering* [*sic*], i.e., saturating the floor with linseed-oil, and then rubbing it over with a peculiar *laque* varnish, and polishing it so as to resemble French polish, like the Berlin hospital floors. Both processes render the floor non-absorbent—both processes do away with the necessity of scouring altogether. The French floor *stands* the most wear and tar, but must be cleaned by a *frotteur*,[8] which cleaning is more laborious than scrubbing, and does not remove the dust. The Prussian floor requires re-preparing every three years. But the wet and dry rubbing, or process of cleaning is far less laborious than either *frottage*[9] or scrubbing, and completely removes the dust, and freshens the ward in the morning. By either process the sick would gain much in England. The Berlin flooring is by no means perfect, on account of this deficient durability of surface, and might be improved.

As to the walls and ceilings of wards, plaster, or brick white-washed, are equally objectionable. Pure, white, polished, non-absorbent cement is the only material fit for hospital walls. If any one has inhabited the wards of War Hospitals, after several weeks or months of constant occupation by sick and wounded, where little or no attempt has been made to lime-wash the uneven dirty plaster-walls, saturated with organic matter, he will not wonder at the stress which is here laid upon the importance of impervious walls.

8. *Defective Condition of Waterclosets*.—It is hardly necessary to say more than this. There can be no safety for the sick if any but waterclosets of the best construction are used, so also if they are not built externally to the main building, and cut off by a lobby, separately lighted and ventilated, from the ward. The same thing may be said of sinks. I have known outbreaks of fever even among the healthy from an ill-constructed and ill-placed sink in this country.

The smell of latrines, which are not waterclosets, as used in French hospitals, although externally built, is quite perceptible at the end of the ward nearest to them.

9. *Defective Ward Furniture*.—Hospital bedsteads should always be of iron, the rest of the furniture of oak. Hair is the only material yet discovered fit for hospital mattresses. It is not hard nor cold. It is easily washed. It does not retain miasma. Straw has the advantage of being easily renewed, but it is not desirable. It is too hard and too cold not to render necessary the use of a blanket *under* the patient, which use is likely to encourage bed-sores. I speak from actual experience of the fatal effect of using the *paillasse*[10] with patients much reduced. It may lower their vital energy beyond repair.

For eating, drinking, and washing vessels, and for other utensils, the use of glass or earthenware is superior to that of tin or any other metal, on account of its greater cleanliness. Notwithstanding the greater amount of breakage and of expense, glass or earthenware is therefore best wherever possible. Some kinds of tin vessels cannot by any amount of cleaning be freed from an unclean smell.

10. *Defective Accommodation for Nurses and Discipline*.—Simplicity of construction in hospitals is essential to discipline. Effectual and easy supervision is essential to proper care and nursing.

Every unneeded closet, scullery, sink, lobby, and staircase represents both a place which must be cleaned (which must take hands and time to clean) and a hiding or skulking place for patients or servants disposed to do wrong. And of such no hospital will ever be free. Every five minutes wasted upon cleaning what had better not have been there to be cleaned, is something taken from and lost by the sick.

In considering the pavilion plan to be in future received as the sanitary necessity for hospital construction, we must look upon it as susceptible of many modifications. In deciding which of these shall be adopted, there are four essentials to be considered as regards the head of nursing and discipline.

1.) Economy of attendance. 2.) Ease of supervision. 3.) Convenience as to number of sick in the same ward and on the same floor, so as to save extra attendants and unnecessary waste of time and strength on the stairs. 4.) Efficiency as to accommodation for nurses so as to overlook their wards.

First. *Economy as to attendance.*—I would rather not enumerate the instances where I have seen that, often from the most various causes, one result arises, *viz.*, that more time and care are given to passages, stairs, &c., than to the sick. Extreme simplicity of construction and of detail is essential to obviate this. A convenient arrangement of lifts, and the laying of hot and cold water all over the building economize attendance—certainly as much as one attendant to every thirty sick.

Secondly. *Ease of Supervision*.—The system of scouts, watch, alarm, is well understood in many wards where patients would be puzzled to give the things names. Some patients will know both things and names. Attendants require inspection as well as patients. Whatever system of hospital construction is adopted should provide for easy supervision at unexpected times. The Vincennes plan is better adapted for this than the Lariboisière plan, inasmuch as there is a greater number of patients on the same level, and stairs are spared.

Third and Fourth. *Distribution of Sick in convenient numbers for attendance, and Position of Nurses' Rooms*.—Four wards of ten patients each, taking the average of patients as in London, cannot be efficiently overlooked by one head nurse. Forty patients in one ward can be fully overlooked by one head nurse. She ought to have her room so placed that she can command her whole ward, day and night, from a window looking into the ward. This cannot be the case if she has four wards. If she has two, they ought to be built end to end, with her room placed between and looking into both wards.

Four wards of ten patients each cannot be attended by one night nurse, taking the average of London cases. Forty patients in one ward can be fully attended by one night nurse.

Small wards are indeed objectionable in working a hospital.

If we are to be guided, however, by the results of recent experience in hospital building, we shall probably come to the conclusion that, taking sanitary and administrative reasons together, thirty-two patients is a good ward-unit.

Let us see what we do in our military hospitals at home. The first thing that will strike any one in most of our regimental hospitals is the extraordinary number of wards, and of holes and corners in comparison with the number of sick. In a hospital for a battalion 500 or 600 strong, you find eight or ten little bed-rooms, miscalled wards, a little kitchen, everything, in fact, on a little scale, like a collapsed French hospital. How much more sensible would it be to have one, or at most two large wards for thirty sick each, with a small 'casualty' ward! How much less the expense of erection and administration, how much easier the discipline and oversight, how much better the ventilation!

To return to large general hospitals. These 'casualty' wards, as they are called, for noisy or offensive cases are much better placed apart, with a completely appointed staff of their own, than attached one small ward to each larger one. Patients requiring much attention, whose condition fits them the most for the small wards, cannot be put there, because either they are more or less neglected or they unduly monopolize the service of the ward attendants. If convalescent patients are put into them, they are comparatively removed from inspection, and often play tricks there. If separate 'casualty' wards are provided as they ought to be, the small ward (often seen in French hospitals), at the end of the larger ward, is only an incubus.

11. *Defective Hospital Kitchens*.—Two facts every careful observer can establish from experience.

1.) The necessity for variety in food, as an essential element of health, owing to the number of materials required to preserve the human frame. In sickness it is still more important, because, the frame being in a morbid state, it is scarcely possible to prescribe beforehand with certainly what it will be able to digest and assimilate. The so-called 'fancies' of disease are in many cases valuable indications.

2.) The importance of cooking so as to secure the greatest digestibility and the greatest economy in nutritive value of food.

Yet so little was either of these elements of health understood in the late Crimean war, so little is either understood up to this hour in the diets, rations, and cooking of either sick or well in the army, that we still see the everlasting sameness of ration, the eternal boiled meat of the 'full,' 'half,' and 'low' diet of the hospital kitchen. As the present Quartermaster-General says, 'the men live upon boiled meat for twenty-one years.'

In the war hospitals of the East it was practically learnt, though never theoretically acknowledged, that in order to make the patient eat at all, he must not be fed on this hard boiled never-varying meat of 'full' or 'half' diet.

Hence the wasteful and violent expenditure of 'extras,' as they are called, which, in the hands of inexperience surgeons, left to their own unassisted inventions, often laid them open to criticism.

But no attempt was made to compose a better or more varied diet, hardly any, till the arrival of Soyer, to improve the system of cooking.

Some few improvements have lately been made in the hospital kitchens of the army at home; what variety of cooking there is even now in the barracks is often done at the expense of, and by the men themselves. A proper system of hospital diets will ere long be introduced in the army hospitals.

I have often been surprised by the primitive kitchens of some of our civil hospitals, with which little variety of cooking is possible.

These things show how little diet and cooking are even yet thought of as sanitary and curative agents. There still exists a confusion of ideas about 'spoiling' the sick, about 'too much indulgence' of the patients, and even yet comparatively little is practically known as to what is, and what is not, essential for restoration to the utmost vigour.

12. *Defective Hospital Laundries.*—It is hardly necessary to go back to the time in the Crimean war when in a Scutari hospital six shirts were washed in a month for an number of 2000 patients, which was constantly changing; when the number per man per month of all articles of all descriptions washed was less than three. The pestilential filth of that time is known now to all. But it is not so well known that even now there is scarcely an army hospital which has such a thing as a laundry. The bedding is generally washed by the barrack department; no one appears to know how. It is done by contract. And the body linen is generally washed, if such a term ought to be used, in a small wash-house, or lean-to shed, with or without a boiler, and without any means for drying, getting-up, or into the damp air, and there hung up for a longer or a shorter time; and if the 'orderly' be careful of his patients, he will complete the process by drying the linen, before it is put on, in front of the ward fire.

A great deal has been said about the communication of 'infectious' disease, both in civil and military hospitals, from patients' linen to washerwomen. The usual conclusion arrived at on such occasions is that such and such a disease is 'very infectious,' *e.g.,* I was lately told in a civil hospital that the washerwomen became infected with fever from the patients' linen. Have those who put forward this doctrine of inevitable 'infection' among washerwomen even examined the process of washing, the appliances by which it is done, and the place where the women wash? If they will do so, they will very generally find a small, dark, wet, unventilated, and overcrowded little room or shed, in which there is hardly space to turn about—so full of steam loaded with organic matter that it is hardly possible to see across the room. Is it surprising that the linen is badly washed, that it is imperfectly dried, and that the washerwomen are poisoned by inhaling organic matter and foul air? An ordinary hospital washhouse is a very likely place indeed to contract disease in, but it supplies equal reason for demurring *in toto* to the doctrine that the occurrence is inevitable, or that the disease is to blame. Ignorance and mismanagement lie at the root of all such presumed cases of 'infection.' And it would better serve the cause of humanity if, instead of citing such facts—if they be facts—as illustrations that such and such a disease in infectious, people would reform these washing establishments and convert them into proper laundries, from which properly cleansed and prepared linen could be supplied to the sick, and in which the health of the servants could be preserved from injury.

Let laundries be constructed with sufficient area and cubic space for each washer, with abundance of water, with proper means of drainage, and of ventilation for removing vapour, and with properly-constructed drying and ironing rooms, and we shall cease to hear of washerwomen 'catching' fever.

13. *Selection of Bad Sites and Bad Local Climates for Hospitals.*—As the object to be attained in hospital construction is to have pure dry air for the sick, it will be evident that this condition cannot be fulfilled if a damp climate be selected. It is a well-known fact, *e.g.*, that in the more damp localities of the south of England, certain classes of sick and of invalids linger, and do not recover their health. Again, retentive clay subsoils keep the air over entire districts of the country always more or less damp. And soils of this character should not be selected as sites for hospitals. Self-draining, gravelly, or sandy subsoils are best. River banks, estuary shores, valleys, marshy or muddy ground, ought to be avoided. It may seem superfluous to state that a hospital should not be built over an old graveyard, or on other ground charged with organic matter. Although hospitals are intended for the recovery of health, people are very apt to forget this, and to be guided in the selection of sites by other considerations—such as cheapness, convenience, and the like; whereas, the professed object in view being to secure the recovery of the sick in the shortest time, and to obtain the smallest mortality, that object should be distinctly kept in view as one which must take precedence of all others.

A doctrine has recently been promulgated in a Government Report, that we are only to consider what is best for the *majority* of the sick in a hospital. If we cannot do the best possible for *all* the sick, by all means let us leave the rest at home. In practice a hospital may be found only to benefit a majority, and to inflict suffering on the remainder. Let us use our intelligence to see whether we cannot have hospitals constructed so as to be of equal benefit to all.

14. *Erecting Hospitals in Towns*.—Nearly all that has been said under the last head, *mutatis mutandis*,[11] may be repeated here. If the recovery of the sick is to be the object of hospitals, they will not be built in towns. If medical schools are the object, surely it is more instructive for students to watch the recovery from, rather than the lingering in, sickness. Twice the number of cases would be brought under their notice in a hospital in which the sick recovered in half the time necessary in another.

According to all analogy, the duration of cases, the chances against complete recovery, the rate of mortality, must be greater in town than in country hospitals.

Land in towns is too expensive for hospitals to be so built as to secure the conditions of ventilation and of light, and of spreading the inmates over a large surface-area, instead of piling them up three or four stories high—conditions now known to be essential to recovery.

15. *Defects of Sewerage*.—Sewers may become cesspools of the most dangerous description, if improperly made and placed. At Scutari, if the wind changed so as to blow up the open mouths of the sewers, such change was frequently marked by outbreaks of fever among the patients, and by relapses among the convalescents from fevers. Where there are no means for externally ventilating the sewers, no means for cleansing or flushing them, and where the bottoms are rough and uneven, such occurrences cannot fail to take place. The emanations from the deposits in the sewers were blown back through the pipe-drains into the privies, and thence into the corridors and wards where the sick were lying. Where sewers pass close to or under occupied rooms, the walls or covers being defective, exhalations will infallibly escape into those rooms. Such could be distinctly perceived in Scutari hospital, and cases of cholera distinctly traced to such a cause.

Not very long ago five fatal cases of fever occurred in rapid succession among the nurses in one of our civil hospitals, which were traced to a defective drain.

Where a main sewer is too large, as in the case at Netley Hospital, mischief may also ensue.

16. *Construction of Hospitals without Free Circulation of External Air.*—To build a hospital with one closed court with high walls, or what is worse, with two closed courts, is to stagnate the air even before it reaches the wards.

All closed corners stagnate the air, even where the building forms but three sides of a square, unless the wings are so short that they can hardly be called wings. The only safe plan is to leave the corners entirely open, as at Vincennes, where they are connected only by an arcade on the ground floor.

To build a hospital in the midst of a crowded neighbourhood of narrow streets and high houses, is to insure a stagnation of the air without, which no ventilation within, no cubic space, however ample, will be able to remedy.

I have here given the defects; few have had so sad or so large an experience of their results as I have had. I appeal to those who are wiser, and have more practical power than I have, for the remedies—to architects, to hospital committees, to civil and royal engineers, to medical officers, to officers of health, to all the men of science and benevolence of whom our country is so justly proud. It is hard that in a country where everything is done by a despotic Government, such advances in the sanitary construction of hospitals should have been made, and that our England, which ought to take the lead in everything good, should be left behind.

Note on the Hospital Plans

These four plans, two English and two French, may be taken as representing the degree of constructive ability to the planning of hospitals in the two countries. The contrast presented by them is certainly very striking.

Compare, for example, the extreme simplicity of the plan of the Military Hospital at Vincennes with the great complication of that at Netley. The former consists of a centre and two wings, detached but connected by a corridor one story high running along the basement. The centre contains the offices, and the wards are in the wings. Each wing consists of two pavilions for sick soldiers, and one small pavilion for sick officers. The pavilions are completely cut off from each other by a large, specially ventilated staircase, carried above the roof. Each ward has a profusion of windows opposite each other, abundance of light and of ventilation, quite independent of the ventilation of the adjoining pavilions. The wards, moreover, run nearly north and south, and receive the sunlight freely throughout the day.

Netley Hospital, on the other hand, presents a perfect rabble of wards and offices, thrown together as if by accident. All the sick wards in each flat have their ventilation connected by a corridor running along and covering the whole south west face of the building, as if designed to obstruct natural ventilation, to keep out sunlight, and to ensure the equal diffusion of a hospital atmosphere throughout the entire line of wards. It is true that a complicated system of ventilation is proposed to remove this latter defect, but there should have been no such defect to remove. It will also be seen that the only ward windows opening to the external air are on the nor-east and coldest side of the building.

Netley may be fairly described as a hospital without sufficient sunlight or natural ventilation.

The Vincennes Hospital has an obvious defect in the position of part of the administrative officials; but even in this respect it is better than Netley, while in all that pertains to the welfare of the sick it is very greatly superior.

Let us next compare the Civil Hospital Plans:—

One of these is that of an unfinished metropolitan hospital; the other is the plan of the noble Lariboisière at Paris. The English hospital plan presents an epitome of almost every defect in hospital construction. It is an involved Netley plan with sick in the corridors, for not only have the wards windows only on one side, but there are four rows of beds between the opposite windows. Moreover, the arrangement of the wards, corridors, chapel, &c., seems as if intended to stagnate the air outside. All is complicated, and there is a want of that simplicity of plan which is essential to the free circulation of air without as well as within the sick wards.

Turn next to the Lariboisière. The corridor running round the central garden is only one story high, so as not to impede the free flow of the air and sunlight. The sick pavilions are all detached from each other. They are, in fact, separate hospitals, with only one hundred sick under one roof. Like the Vincennes pavilions, they have a profusion of windows, and abundant means of natural ventilation within as well as without. In the much brighter and hotter, as well as colder climate of Paris, a large proportion of the hospital wall is glass, and the sick are ranged between the windows, so that the ward effluvia can readily escape.

The English plans, on the contrary, show that in our duller and milder climate, in both senses, our hospital architects do their best to shut out our rare and imperfect sunlight, and to keep pure air out of the wards as much as possible, while they provide for the sick being so arranged that the effluvia must pass over a succession of beds before escaping.

Any one making even a cursory examination of these four plans can hardly fail to arrive at the conclusion that the French plans, with certain obvious defects, show a high appreciation of the importance of hospital hygiene; while the English plans, on the contrary, prove that we have hardly yet begun even to study this branch of knowledge.

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CHAPTER 16

IGNÁC SEMMELWEIS
(1818–1865)

Heaven grant that the burden you carry may have as easy an exit as it had an entrance.

—DESIDERIUS ERASMUS, *Prayer for a Pregnant Woman*, c. 1500

BORN ON JULY 1, 1818, in Taban, a commercial section of Buda, Hungary, Ignác or Ignaz Philipp Semmelweis was the fifth child of a well-to-do shopkeeper. Though Jewish, he attended the Catholic Gymnasium of Buda for high school and studied at the University of Pest from 1835 to 1837. Under parental pressure to become an attorney, Semmelweis went to Vienna to study law; however, he found himself more interested in medicine, and subsequently he enrolled in medical school instead. After a year, he returned to Pest for further undergraduate work, after which he went to the Second Vienna Medical School to complete his medical training.

The Vienna medical community of the late 1830s was beginning to flower, with the presence of residents such as pathologist Carl Freiherr von Rokitansky, dermatologist Josef Skoda, and others making their impact. After receiving a Magistar degree in 1844, Semmelweis trained for 15 months in clinical research methods under Skoda. With his training complete, Semmelweis was appointed as an assistant at the First Obstetrical Clinic at the Vienna General Hospital, becoming the house officer of that clinic in July 1846.

Vienna in the 1840s was a regional center with intellectual ferment; however, the fever for revolutionary change did not extend to the clinics at the Vienna General Hospital. Puerperal fever was a major challenge for obstetrics in the first half of the nineteenth century, but the Viennese obstetrical establishment chose to view it as an inevitable part of childbirth. Semmelweis, however, made the astute observation that while the maternal mortality rate from puerperal fever in the First Obstetrical Clinic was greater than 12 percent, the rate in the Second Obstetrical Clinic, run by midwives and serving the same patient population, was barely 2 percent. He was puzzled by this discrepancy, but he did not have a hypothesis that might explain it.

In 1847, Jakob Kolletschka, one of Semmelweis's friends, performed an autopsy during which he cut himself on the finger. Kolletschka soon developed an infection and died. The postmortem on Kolletschka's body identified pathology consistent with puerperal fever, yet that diagnosis was clearly not possible. Semmelweis concluded that some cadaveric substance must have entered Kolletschka's body when he cut himself and that that substance must have been the source of the infection. He also concluded that medical students and physicians who came directly from working on cadavers to attend patients at the clinic might be transmitting the agent that caused puerperal fever. Semmelweis conducted several studies to validate his hypothesis and then implemented a policy of washing hands in chloride of lime after autopsy work to remove any cadaveric substance remaining on the hands before attending patients. The puerperal fever mortality rate for the First Obstetrical Clinic immediately fell to that of the Second Obstetrical Clinic once the handwashing policy was instituted.

The medical establishment did not embrace Semmelweis's findings. The suggestion that physicians could be the source of iatrogenic disease did not sit well with the medical community. Semmelweis's claims were challenged as unsubstantiated, requiring too much unnecessary work on the part of physicians and students. It is also difficult to discount the impact that anti-Semitism and personality conflicts played in the rejection of Semmelweis's ideas.

Despite rejection, Semmelweis persisted in his investigations, adding a requirement that all instruments be cleansed in chloride of lime before they could be used in a patient. The practice caused puerperal fever to practically disappear from the wards of the First Obstetrical Clinic. Yet political forces intervened. In 1848, conservatives took over the government, and Semmelweis was summarily fired from his position. Although his friends tried to rally around him, he left Vienna in 1850 without informing any of them of his whereabouts or plans for the future.

In 1851, Semmelweis settled back in Pest, where he directed the obstetrical wards at the St. Rochus Hospital. While building a successful private practice, he married and had five children. In 1855, Semmelweis was appointed chair of the midwifery department at the University of Pest. Two years later, he was offered the chair of the obstetrics department in Zurich, which he declined. By 1860, Semmelweis felt confident enough in his position in Pest to publish *The Etiology, Concept and Prophylaxis of Childbed Fever*. The book met with much derision from the medical community. It is difficult to determine how much of this response reflected the strong anti-Semitism present in the medical communities of Germany and Austria.

Semmelweis did not handle this rejection well. By 1865, he had sustained either a nervous breakdown or the onset of Alzheimer's disease; it is not clear which disease he had. Sent to an insane asylum in Vienna, Semmelweis became violent and was beaten by the asylum staff. Within a fortnight, he died from the injuries received during the beating.

A Note on the Text

The selected reading is taken from Semmelweis's 1860 publication *The Etiology, Concept and Prophylaxis of Childbed Fever.* The book showcases Semmelweis's insightfulness in identifying the likely cause of puerperal fever and the careful experiments performed to test his hypothesis. It carefully describes his recommended approach for preventing puerperal fever and offers statistics from his experiments to underscore the recommendations. The care with which the approach is to be implemented at hospitals is also worthy of note.

Given that Semmelweis seems to have performed some exemplary scientific experiments, one might wonder why his work was so readily dismissed. The truth is that large portions of *The Etiology, Concept and Prophylaxis of Childbed Fever* are very unscientific, containing rants against those who did not readily accept his findings. What comes through is Semmelweis's frustration with the medical community and his fragile state of mental health. The publication gave his critics fodder to use against him, both to undermine his claims and to show that he was insane.

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The Etiology, Concept and Prophylaxis of Childbed Fever
(1860, Abridged)

CHAPTER 5
Prophylaxis of Childbed Fever

The only cause of childbed fever is decaying animal-organic matter that is either introduced to the individual from external sources or generated internally. Thus, the prophylaxis of childbed fever involves preventing the introduction of external decaying matter, preventing the internal generation of decaying matter, and removing as quickly as possible any existing decaying matter or preventing its resorption.

Decaying matter is usually spread in manual examinations. Given a large number of students, it is safer to avoid contamination than to clean what has once been contaminated. I therefore appeal to all governments to proclaim laws forbidding those engaged in maternity hospitals from activities likely to contaminate their hands. The imperative necessity of such laws is made clear by my experience in the first clinic; in spite of all my exertions, I did not succeed in limiting childbed fever to cases of self-infections. Bear in mind that the semester for practical obstetrics does not begin on a fixed day when all can simultaneously be made aware of their responsibilities. Rather, a few students join and leave each day. Because one cannot repeat the same things every day, it can easily happen that many are first warned after they have been there several days. Consider that the forty-two students in the first clinic spend the largest part of their day in the morgue performing pathological and forensic autopsies, in the divisions of the general hospital, in various operations, and in other courses. In all these activities, their hands become not only contaminated but actually saturated with decaying matter. Moreover, although it is difficult to believe, these students will not take the time necessary for chlorine washings to disinfect their hands completely. When one considers these circumstances, it is understandable that there were still cases of infection from external sources in the first clinic.

This evil situation can only be corrected by the law mentioned above. This law would have other beneficial consequences. I will later cite numerous professors of obstetrics who have written against my teaching. Only a fool could believe that students who have been taught so fallaciously will disinfect themselves as conscientiously as necessary. And when death reaps a rich harvest, the failure of chlorine washing is cited as evidence for the epidemic origin of childbed fever.

The pernicious behavior—whereby many human lives are prematurely destroyed, whereby additional generations of misled physicians are sent out into practice, and whereby cases of infection outside the maternity hospitals are then used as evidence that childbed fever is epidemic—can only be ended by such laws. If, in consequence of the law, students in maternity hospitals have clean hands, then the most ardent lecture on epidemic influences will no longer cause epidemics. Without this law, such lectures make students careless, and childbed fever is increased by hands contaminated with decaying matter. I therefore implore all governments to proclaim such laws in order that the childbearing sex will not be further decimated, in order that life yet unborn will not be infected with seeds of death by those very persons who are called to protect life. Such a law would not hinder other aspects of medical education, because practical obstetrics is a relatively short course. Moreover, the law would significantly promote the teaching of practical obstetrics, because the most informative cases would not longer occur while students are occupied in other activities. Theoretical obstetrics is used everywhere to introduce instruction in practical obstetrics. Operations on corpses should be part of this theoretical instruction. Students attending lectures on theoretical obstetrics should attend autopsies of those who die in the maternity hospitals. Then, before being admitted into the maternity hospital, they would be familiar with the pathological anatomy of childbed fever and with obstetrical operations on corpses. This would make such activities [as autopsies] unnecessary while students are involved in the hospitals. Such laws would eliminate the most prolific, but by no means the only, activities in which hands become contaminated. Even in maternity hospitals childbed fever can originate through self-infection; when this takes the form of septic endometritis, the hands of the examiner can become contaminated. Also, patients are admitted who suffer from diseases that produce decaying matter. Thus it will always be necessary to disinfect the hands.

In order to disinfect the hands completely it is necessary to oil them before they are contaminated so that the decaying matter cannot penetrate the pores. Thereafter the hands just be washed with soap and then exposed to the operation of a chemical agent to destroy the decaying matter. I employ chloride of lime and wash as long as is necessary to make the hands slippery. Hands treated in this way are completely disinfected. Decaying matter is carried not only by the examining finger but also by everything contaminated that can come into contact with the genitals. These items must, therefore, either be disinfected or no longer used.

Because air can also carry decaying matter, maternity hospitals must be built in areas where no decaying matter can be conveyed to them. Thus, maternity hospitals should not be part of large general hospitals. So that air in the maternity hospitals will not carry decaying matter, exhalations of the individuals in hospitals must be removed by ventilation before decomposition begins. It is also necessary that every maternity hospital contain several isolation rooms in order that individuals who exude decaying matter can be isolated. It is unimportant how many healthy patients are cared for in one room so long as the number of patients is appropriate for the size of the room. In the first clinic we cared for thirty-two patients in one room.

The prophylaxis of childbed fever does not require that several small maternity hospitals be erected in place of one large one. Certainly total mortality cannot be as great in a small hospital as in a large one; for example, in the maternity clinic at Würzburg, Kiwisch reported 27 deaths from 102 patients cared for during one year. The least favorable year of the seventy-five years of the Viennese maternity hospital was 1842; taking the hospital as a whole, of 6,024 patients, 730 died: in the first clinic alone, of 3,287 patients, 518 died. What a horrible difference between the total number of deaths in the small hospital in Würzburg and the large one in Vienna. Nevertheless, the relative mortality in the small Würzburg hospital was significantly larger than even the worst year in the largest maternity hospital in the world; in Würzburg, 26.47 percent died, in Vienna for the hospital as a whole only 12.11 percent, and in the first clinic alone only 15.75 percent died. It is easy to explain why the relative mortality in smaller maternity hospitals is greater than in large ones. In small hospitals the teaching material is restricted and every patient must be used. If they are examined with contaminated hands, a high percentage of the patients will become infected. In Vienna there is such an excess of teaching material that hundreds of individuals are not used for teaching and thus are not infected.

To prevent self-infection, one must prevent decaying matter from being generated internally during delivery. When delivery is prolonged so that the genitals become crushed, it is necessary that the required operation be concluded as quickly as possible. The operation itself must be carried out carefully; otherwise it could result in that very state [death] for the prevention of which the operation was carried out. Thus rotation and pendular movements with forceps, for example, are reprehensible because the genitals are necessarily crushed in the process.

Remnants of the placenta and membrane must be extracted from the organism before they begin to decompose. Several hours after the uterus ceases to bleed, injections must be given in order to remove any clotted blood that remains within; otherwise this begins to decompose and leads to self-infection. One must avoid perineal lacerations, because these provide both a resorbant surface and resorbable matter. Once decaying matter is created it must be removed through cleanliness and injections so that resorption is avoided where possible. To the extent that these circumstances also arise outside the maternity hospital, the same prophylaxis must be observed.

In order that these measures will be observed everywhere, medical personnel must be made to swear in the oath and in the official instructions given when they receive their diplomas that they will conscientiously discharge all that is required by these prophylactic measures. Instead of losing 1 patient for every 3 or 4 that are admitted, those who observe these measures may lose as few as 1 in 400—certainly less than 1 in 100.

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CHAPTER 17

ROBERT KOCH
(1843–1910)

If the number of victims which a disease claims is the measure of its significance, then all diseases, particularly the most dreaded infectious diseases, such as bubonic plague, Asiatic cholera, etc., must rank far behind tuberculosis. One in seven of all human beings die from tuberculosis. If one only considers the productive middle-age groups, tuberculosis carries away one-third, and often more.

—Robert Koch, *The Aetiology of Tuberculosis*, 1882

Robert Koch was born on December 11, 1843, at Clausthal in the Upper Harz Mountains of Germany. He taught himself to read by the age of five, developed a keen interest in biology during his high school years, and went to the University of Göttingen to study medicine in 1862. While at Göttingen, Koch was exposed to the teaching of Jacob Henle, then professor of anatomy. Henle had already published his ideas about infectious diseases being caused by living, parasitic organisms in 1840, and this logical approach to biological research impressed Koch greatly. After completing his M.D. degree in 1866, Koch went to Berlin for six months, where he was further influenced by Rudolf Virchow. In that year, he married Emmy Fraats, with whom he fathered his only child, Gertrud. Koch entered general medical practice in 1867 and consequently passed the examination to become a district medical officer. After volunteering and serving in the Franco-Prussian war, Koch returned to Germany, serving as district medical officer for Wollstein from 1872 to 1880.

The farm animals in Wollstein suffered from outbreaks of anthrax, and Koch became determined to understand the disease. He created a laboratory in his small flat, with his scientific instrumentation limited to a microscope given to him by his wife. Although the anthrax bacillus had already been discovered by Alloys Pollender, Pierre Rayer, and Casimir Davaine, it had not yet been proven that the bacillus was the sole cause of the disease. Koch was determined to make this link. He experimented with mice and confirmed that the disease could be transmitted via the blood of animals suffering from anthrax. This, unfortunately, did not address whether it was the bacillus that was the sole causative agent or whether something else in an infected animal could be the cause. Koch grew several generations of anthrax in pure cultures and showed that the organisms could still cause anthrax despite the fact that they had not come into contact with any animal. He now had his proof. Koch took his results to scientists at the University of Breslau, who were impressed. He gave a lecture on the results that became an instant classic. Indeed, he became famous for his tuberculosis research almost overnight.

In 1880, Koch was appointed a member of the Reichs-Gesundheitsamt (Imperial Health Bureau) in Berlin, where he worked with assistants to refine and develop new bacteriological methods. He invented *Reinkulturen*, a method of cultivating pure bacterial cultures on solid media in a flat dish invented by his colleague Julius Richard Petri. Koch also set out the conditions, or postulates, that must be satisfied in order to prove that particular bacteria cause a particular disease.

While in Berlin, Koch discovered the tubercle bacillus and devised a method of growing it in culture. He published his work on tuberculosis in 1882 and in 1883 led the German Cholera Commission's investigation of a cholera outbreak in Egypt. It was in Egypt that Koch discovered the causative agent of cholera, returning with pure cultures of *vibrio* for research in his laboratories in Germany. Koch laid out rules for controlling cholera outbreaks, rules that are still in use today. His efforts earned him a prize of 100,000 German marks.

In 1885 Koch was appointed professor at the University of Berlin and made director of that university's Institute of Hygiene. He returned to research on tuberculosis, seeking a cure through what he called "tuberculin," a substance made from pure cultures of tubercle bacilli. While tuberculin did not turn out to be a cure, it did become an important substance for diagnosing the disease.

Koch's ability to address infectious diseases in humans and animals was extensive. He studied the origin of rinderpest in South Africa; malaria, blackwater fever, and the surra of cattle and horses in India; and plague. In 1901, he concluded that human and bovine tuberculosis are not identical diseases, causing much controversy at the International Medical Congress on Tuberculosis in London. Koch also claimed that typhus is more likely to be spread from person to person than from drinking water, suggesting new control measures. He studied East Coast Fever of cattle in Africa and made important discoveries about babesiosis, trypanosomiasis, and tickborne spirochetosis. In 1905 he was awarded the Nobel Prize for Physiology of Medicine.

Koch was the recipient of many other prizes and medals, including honorary doctorates from the Universities of Heidelberg and Bologna. He held multiple honorary memberships in academic societies in Berlin, Naples, New York, Perugia, Posen, and Vienna. He was awarded the German Order of the Crown, the Grand Cross of the German Order of the Red Eagle, and Orders from Russia and

Turkey for his research. Awards to Koch continued posthumously for many years after his death in Baden-Baden on May 27, 1910.

A Note on the Text

Two readings are presented here. The first is Koch's lecture and subsequent publication on the etiology of tuberculosis. The second covers his lecture on the criteria designed to establish a causal relationship between a microbe and a disease. While the first is the one that set a new standard for bacteriological research in the twentieth century, it is the second that is most referred to in lectures on public health.

For the tuberculosis (TB) lecture at the University of Breslau, Koch brought microscopes, test tubes with cultures, slides of stained bacteria, dyes, reagents, tissue samples, and more. His intent was to show how the infection moved through the tissues of both patients and animals infected with TB. This lecture is said to have ended with the audience in complete silence—no applause—because they were so stunned. Paul Ehrlich (1908 Nobel Laureate in Physiology or Medicine) was in the audience that evening and noted, "I hold that evening to be the most important experience of my scientific life." Koch's experimental results and logic on the etiology of tuberculosis were rapidly published on April 10 in a German medical journal and again in English translations in *The Times* (London) on April 22 and the *New York Times* on May 3, 1882. It is from this public exposure that Koch immediately became known as "The Father of Bacteriology."

The lecture that laid out Koch's postulates received less fanfare. Indeed, Friedrich Gustav Jacob Henle had already published four postulates for showing the causal link between a particular infectious agent and a particular disease as early as 1840. Koch and Friedrich Loeffler, an assistant in Koch's research laboratories, refined Henle's postulates and applied them to anthrax and tuberculosis in 1884. The refined postulates that allowed generalization to other diseases were presented in his lecture of 1890. Even Koch, however, found the refined postulates somewhat flawed. When asymptomatic carriers of cholera and later "Typhoid Mary" were discovered, Koch abandoned the second part of the first postulate: "The organism must be found in all animals suffering from the disease, but not in healthy animals." He also discovered in his research on cholera and tuberculosis that the third postulate does not always happen: "The cultured organism should cause disease when introduced into a healthy animal." Today, some bacteria (such as the one that causes leprosy) still cannot be grown in pure culture, and some infections have no known animal model other than humans. We also know that what are normally nonpathogenic bacteria may acquire virulence if they gain access to deep tissues or if they infect an immunocompromised patient. Despite this new knowledge, the clarity with which Koch presents his research and his postulates is unparalleled.

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The Aetiology of Tuberculosis
(1882)

Villemin's discovery that tuberculosis is transmissible to animals has, as is well known, found varied confirmation, but also apparently well-grounded opposition, so that it remained undecided until a few years ago whether tuberculosis is or is not an infectious disease. Since then, however, inoculations into the anterior ocular chamber, first performed by Cohnheim and Salomonsen, and later by Baumgarten, and furthermore the inhalation experiments done by Tappeiner and others have established the transmissibility of tuberculosis beyond any doubt, and in future tuberculosis must be classed as an infectious disease.

If the number of victims which a disease claims is the measure of its significance, then all diseases, particularly the most dreaded infectious diseases, such as bubonic plague, Asiatic cholera, etc., must rank far behind tuberculosis. Statistics teach that one-seventh of all human beings die of tuberculosis, and that, if one considers only the productive middle-age groups, tuberculosis carries away one-third and often more of these. Public hygiene has therefore reason enough to devote its attention to so destructive a disease, without taking into any account that still other conditions, such as the relations of tuberculosis to *Perlsucht*,[1] engage the interest of Public Health.

Since it is part of the task of the *Gesundheitsamt*[2] to investigate infectious diseases from the point of view of public health, that is, primarily as regards their aetiology, it seemed an urgent duty to make thorough studies on tuberculosis particularly. There have been repeated attempts to fathom the nature of tuberculosis, but thus far without success. The so frequently successful staining methods for the demonstration of pathogenic microorganisms have failed in regard to this disease, and, to date, the experiments designed to isolate and cultivate a tubercle virus cannot be considered successful, so that Cohnheim, in the recently published and newest edition of his lectures on general pathology had to designate "the direct demonstration of the tuberculous virus as a still unsolved problem."

In my studies on tuberculosis I first used the known methods without elucidating the nature of the disease. But by reason of several incidental observations I was prompted to abandon these methods and to follow other paths, which finally led to positive results.

The aim of the study had to be directed first toward the demonstration of some kind of parasitic forms, which are foreign to the body and which might possibly be interpreted as the cause of the disease. This demonstration became successful, indeed, by means of a certain staining process, which disclosed characteristic and heretofore-unknown bacteria in all tuberculous organs. It would take us too far a field to tell of the road by which I arrived at this new process, and I shall therefore immediately give its description. The objects for study are prepared in the usual fashion for the examination for pathogenic bacteria. They are either spread on the cover-slip, dried and heated, or they are cut in sections after being hardened in alcohol. The cover-slips or sections are put in a staining solution of the following formula: 200 cc of distilled water are mixed with 1 cc of a concentrated alcoholic methylene-blue solution, and with repeated shaking 0.2 cc of a 10 per cent potassium-hydrate solution is added. This mixture should not produce a precipitate even after standing for several days. The objects to be stained remain in it from 20 to 24 hours. By heating the staining solution to 40°C in a water-bath this time can be shortened to from one-half to one hour.

The cover-slips are then covered with a concentrated aqueous solution of vesuvin, which must be filtered each time before use and rinsed after one to two minutes with distilled water. When the cover-slips are removed from the methylene-blue the smear looks dark blue and is much overstained, but upon the treatment with vesuvin the blue color disappears and the specimen appears faintly brown. Under the microscope all constituents of animal tissue, particularly the nuclei and their disintegration products, appear brown, with the tubercle bacilli, however, beautifully blue. With the exception of leprosy bacilli, all other bacteria which I have thus far examined in this respect assume a brown color with this staining method. The color contrast between the brown-stained tissue and the blue tubercle bacilli is so striking, that the latter, which are frequently present only in very small numbers, are nevertheless seen and identified with the greatest certainty.

Sections are treated quite similarly. They are transferred from the methylene-blue solution into the filtered vesuvin solution, in which they remain from fifteen to twenty minutes, and are then rinsed in distilled water until the blue color has disappeared and a more or less distinct brown stain remains. They are then dehydrated with alcohol and cleared in oil of cloves, and are either at once microscopically examined directly in this fluid or are finally embedded in Canada-balsam. In these preparations the tissue constituents appear brown and the tubercle bacilli a vivid blue.

Incidentally, the bacteria can be stained not only with methylene-blue, but they take also other aniline dyes, with the exception of brown dyes, under the simultaneous action of an alkali; but their staining is not so beautiful by far as with methylene-blue. In the staining process mentioned the potassium-hydrate solution can be substituted by sodium hydroxide or ammonia water, from which one may conclude that the potassium does not play an essential role, but it is the strongly alkaline reaction of the solution, which counts. This is further confirmed by the fact that a stronger addition of potassium will stain bacteria in such places where a weaker potassium solution fails. But the tissues in sections shrink and change so much under the influence of stronger potassium solutions that the latter are only exceptionally of advantage.

In several respects the bacteria made visible by this process exhibit a characteristic behavior. They are rod-shaped, and they belong to the group of bacilli. They are very thin and one-fourth to one-half as long as the diameter of a red blood-corpuscle, although they may sometimes reach a greater length, up to the full diameter of an erythrocyte. In shape and size they bear a striking similarity to leprosy bacilli. They are differentiated from the latter by being a bit more slender and by having tapered ends. Further, leprosy bacilli are stained by Weigert's nuclear stain, while the tubercle bacilli are not. Wherever the tuberculous process is in recent evolution and is rapidly progressing, the bacilli are present in large quantities; they usually form, then, densely bunched and frequently small braided groups, often intracellular; and they present at times the same picture as leprosy bacilli accumulated in cells. In addition, numerous free bacilli are found. It is particularly at the margin of larger caseous foci that there occur practically only shoals of bacilli, which are not enclosed in cells.

As soon as the height of tubercle-development is passed the bacilli become rarer, and occur only in small groups or quite singly, in the margin of the tuberculous focus and side by side with weakly stained and sometimes hardly recognizable bacilli, which are presumably dying or dead. Finally, they may disappear completely; but they are but seldom entirely absent and, if so, only in such places in which the tuberculous process has come to a standstill.

If giant cells occur in the tuberculous tissue the bacilli are by predilection within these formations. In very slowly progressing tuberculous processes, the interior of giant cells is usually the only place in which bacilli are to be found. In this case the majority of giant cells enclose one or a few bacilli; and it produces a surprising impression to find repeatedly in large areas of the section groups of giant cells, most of which contain one or two tiny blue rods in the center, and within the wide space enclosed by brown-stained nuclei. Frequently, the bacilli are seen only in small groups of giant cells, sometimes only in single cells, while simultaneously many other giant cells are free from them. Then, by their size and position, the bacilliferous cells are recognized as the younger ones, while those free from bacilli are the older ones; and it may be assumed that originally the latter also enclosed bacilli, which have died or changed into a resting state, soon to be mentioned. Analogous to the formation of giant cells around foreign bodies, such as vegetable fibres and strongylus eggs, observed by Weiss, Friedländer and Laulamié, it may be assumed that the bacilli, acting as foreign bodies, are enclosed by giant cells; therefore it seems justifiable to assume that, even when the giant cell is found empty while all other features indicate processes as tuberculous, the giant cell was formerly the host of one or several bacilli, and that the latter have been responsible for their formation.

The bacilli are also observable unstained in unprepared specimens. For this it is necessary to take a little material from such places as contain considerable numbers of bacilli, for example, from a gray tubercle from the lung of a guinea pig, dead of inoculation tuberculosis. This material must be examined after the addition of a little distilled water or, preferably, blood-serum, and best in a hollow slide, in order to avoid streaming in the fluid. The bacilli appear then as very fine rods which show only molecular, but not the slightest trace of intrinsic movement.

Under certain conditions to be mentioned later the bacilli form spores even in the animal body. Individual bacilli contain several, usually two to four spores, oval in shape, and distributed at even intervals along the entire length of the bacillus.

In regard to the occurrence of bacilli in the various tuberculous manifestations in human beings and animals it has been possible to examine the following material thus far:

(1) *From Human Beings: Eleven cases of miliary tuberculosis:* The bacilli never failed of demonstration in miliary tubercles of the lungs; frequently, however, they could not be found any more in those tubercles whose center no longer stained with nuclear dyes. However, they were then still present, and all the more numerous, in small groups in the margin of the tubercle and in younger nodules as yet without central caseation. They were demonstrable, also, in miliary tubercles of the spleen, liver and kidneys, and quite numerous in the gray nodules of the pia mater in basilar meningitis. The caseated bronchial lymph nodes which were examined in several cases contained, in part, dense shoals of bacilli and among them many spore-bearing ones. Tubercles, embedded partly in the lymphoid tissue with a central giant cell surrounded by epithelioid cells, showed some tubercle bacilli within the giant cells.

Twelve cases of caseous bronchitis and pneumonia (in six cases cavity formation); the presence of bacilli was usually limited to the margin of the caseously infiltrated tissue, where several times, however, they were very numerous. Also, within the infiltrated portions of the lung one occasionally encounters nests of bacilli. In most cavities the bacilli are abundant, and the well-known small caseous particles in the cavity contents consist almost completely of bacillary masses. Among those bacilli found in soft caseous foci and in cavities there were, now and then, numerous spore-bearing bacilli.

In larger cavities the bacilli occur mixed with other bacteria. However, they were easily distinguishable because, with the staining-method mentioned, only tubercle bacilli stain blue while other bacteria assume a brown color.

One case of solitary tubercle in the brain, larger than a hazelnut: The caseous part of the tubercle was enclosed by a cellular tissue in which were embedded many giant cells. Most of these did not contain any parasites, but here and there were encountered groups of giant cells, each of which contained one or two bacilli.

Two cases of intestinal tuberculosis: In tuberculous nodules, which were grouped around the intestinal ulcers, the bacilli were demonstrable with particular ease. Here again they were predominantly numerous in the youngest and smallest nodules. In the mesenteric lymph nodes of these two cases bacilli were present in great numbers.

Three cases of freshly excised scrofulous lymph nodes: In only two of them could bacilli be demonstrated in giant cells.

Four cases of fungoid arthritis: In two cases separate small groups of giant cells contained bacilli.

(2) *From Animals: Ten cases of Perlsucht with calcified nodules in the lungs, in several cases also in the peritoneum and once on the pericardium:* In all cases bacilli were found predominantly within giant cells in the tissue surrounding the calcareous masses. The distribution of the bacilli is most frequently so even that among numerous giant cells there is hardly one which does not contain one or several bacilli, and sometimes as many as twenty. In one of these cases the bacilli could also be demonstrated in the bronchial lymph nodes and in a second case in the mesenteric lymph nodes.

Three cases in which the lungs of cattle contained, not the well-known calcified nodules with knobby surface, as usually seen in Perlsucht, but smooth-walled, spherical nodes, filled with a thick, cheesy material: Usually this form is not regarded as tuberculosis but is interpreted as bronchiectasis. In the neighborhood of these nodules were found giant cells containing tubercle bacilli.

A caseated cervical lymph node from a hog likewise contained the bacilli.

Large amounts of tubercle bacilli were found in the organs of a chicken dead of tuberculosis, both in tubercles in the bone-marrow and in the peculiar large lymph nodes of the intestines, the liver, and the lungs. Of three monkeys which had died spontaneously of tuberculosis, the lungs, spleen, liver and [o]mentum, all studded with innumerable nodules, and the caseated lymph nodes were examined; and bacilli were found everywhere in the nodules or in immediate proximity to them.

Of spontaneously diseased animals, nine guinea pigs and seven rabbits were examined; all showed bacilli in the tubercles.

In addition to these cases of spontaneous tuberculosis, I could avail myself of a not inconsiderable number of animals which had been infected by inoculation with the most varied tuberculous materials: as, for instance, with gray and caseated tubercles from human lungs, with sputum from consumptives, with tuberculous masses from spontaneously diseased monkeys, rabbits and guinea pigs, with masses of calcified or caseated lesions from *Perlsucht* in cattle, and finally with material from lesions obtained by animal-passage.

The number of animals so infected amounted to 172 guinea pigs, 32 rabbits and five cats. In the majority of these cases the demonstration of bacilli had to be limited to the examination of tubercles in the lungs, which were always present in large numbers. Here bacilli never failed to be found: frequently they were extraordinarily numerous, and sometimes spore-bearing, but in some preparations only a few yet unmistakable individual forms were observed.

Considering the regularity of the presence of tubercle bacilli it is striking that so far they have not been seen by anyone. But this is explained by the fact that the bacilli are extraordinarily small formations, and are usually so scanty in number, particularly when their occurrence is limited to the interior of giant cells, that for this reason alone they are not detectable by the most attentive observer without the use of quite specific staining-reactions. When present in larger numbers, they are mixed with a finely granular detritus, and obscured by it in such a manner that their visualization is made difficult in the highest degree.

Incidentally, there exist some reports about the finding of microorganisms in tuberculous tissue. For example, Schüller, in his paper on scrofulous and tuberculous arthropathies, mentions that he has constantly found micrococci. Just as the very small motile granules which were found in tubercles by Klebs, these micrococci are undoubtedly something entirely different from the tubercle bacilli seen by me, which are non-motile and rod-shaped. Furthermore, in the first issue of his pathological reports Aufrecht states that, besides two different types of micrococcus, he has seen short, rod-like formations whose length was twice their breadth. He saw these rods in the centre of tubercles in three of a series of rabbits which he had infected with *Perlsucht* and tuberculous material. But tubercle bacilli are at least five times as long as they are thick, and often much longer yet in relation to their thickness; furthermore, in cases of uncomplicated tuberculosis they never occur mixed with micrococci or other bacteria in the tubercles. For this reason it is extremely unlikely that Aufrecht saw the real tubercle bacilli; had he done so, he would then have necessarily demonstrated their occurrence in human tubercles and in lungs with *Perlsucht*, and he could not have escaped noticing the conspicuous relationship between the bacilli and the giant cells.

On the basis of my numerous observations I consider it established that, in all tuberculous affections of man and animals, there occur constantly those bacilli which I have designated tubercle bacilli and which are distinguishable from all other microorganisms by characteristic properties. However, from the mere coincidental relation of tuberculous affections and bacilli it may not be concluded that these two phenomena have a causal relation, notwithstanding the not inconsiderable degree of likelihood for this assumption that is derivable from the fact that the bacilli occur by preference where tuberculous processes are incipient or progressing, and that they disappear where the disease comes to a standstill.

To prove that tuberculosis is a parasitic disease, that it is caused by the invasion of bacilli and that it is conditioned primarily by the growth and multiplication of the bacilli, it was necessary to isolate the bacilli from the body; to grow them in pure culture until they were freed from any disease product of the animal organism which might adhere to them; and, by administering the isolated bacilli to animals, to reproduce the same morbid condition which, as known, is obtained by inoculation with spontaneously developed tuberculous material.

Disregarding the many preliminary experiments, which served for the solution of this task, here again the finished method will be described. Its principle rests on the use of a solid transparent medium, which retains its solid consistence at incubator temperature. The advantages of this method of pure culture, which I have introduced into bacteriology, I have explained in detail in an earlier publication. That the really complicated task of growing tubercle bacilli in pure culture was achieved by this method is to me a new proof of its efficiency.

Serum from sheep- or cattle-blood, separated as pure as possible, is put into test-tubes closed with a cotton stopper and heated every day to 58°C for six subsequent days. It is not always possible to sterilize the serum completely by this process, but in most cases it suffices. Then the serum is heated to 65°C during several hours, or sufficiently long for it to be just coagulated and solidified. After this treatment it appears as an amber-yellow, completely transparent or only slightly opalescent, solid, jelly-like mass; and after several days at incubator temperature it must not show the slightest development of bacterial colonies. If the heating exceeds 75°C or if it lasts too long, the serum becomes opaque. In order to obtain a large surface for the preparation of the cultures the serum is solidified in test-tubes slanted as much as possible. For those cultures intended for direct microscopic examination the serum is solidified in flat.

Upon this solidified blood-serum, which forms a transparent medium that remains solid at incubator temperature, the tuberculous materials are applied in the following manner: The simplest case in which the experiment is successful is presented, almost without exception, when an animal which has just died of tuberculosis, or a tuberculous animal which has just been killed for this purpose, is at one's disposal. First, the skin is deflected over the thorax and abdomen with instruments flamed just before use. With similarly prepared scissors and forceps, the ribs are cut in the middle, and the anterior chest wall is removed without opening the abdominal cavity, so that the lungs are to a large extent laid free. Then the instruments are again exchanged for freshly disinfected ones, and single tubercles or particles of them, of the size of a millet-seed, are quickly excised with scissors from the lung tissue, and immediately transferred to the surface of the solidified blood-serum with a platinum wire, which has been melted into a glass rod which must be flamed immediately before use. Of course, the cotton stopper may be removed for only a minimal time. In this manner a number of test-tubes, about six to ten, are implanted with tuberculous material, because, with even the most cautious manipulation, not all test-tubes remain free from accidental contamination.

Lymph nodes in a state of incipient caseation are as well suited for this experiment as are pulmonary tubercles; less so, however, the pus from liquefied lymph nodes which usually contains very few bacilli or none at all.

The direct isolation of bacilli from tuberculous human organs or from lungs with *Perlsucht* is more difficult. Objects of this kind, whose excision from the body I could not attend to with all the precautions just mentioned, I have washed carefully and repeatedly with a solution of bichloride of mercury, and have then removed their superficial layers with flamed instruments and taken the substance for inoculation from a depth which putrefactive bacteria had presumably not yet invaded.

The test-tubes, provided with tuberculous substance in the described manner, are kept in the incubator at a constant temperature of 37° or 38°C. In the first week no noticeable alteration occurs. If some change does occur and if, already during the first days, bacterial growth develops, starting from the inoculation material or even remotely from it and spreading, and appearing usually as whitish-gray or yellowish drops, and often liquefying the solid serum, then one is dealing with contaminations and the experiment has failed.

Cultures that result from a growth of tubercle bacilli do not appear to the naked eye until the second week after the seeding, and ordinarily not until after the tenth day. They come into view as very small points and dry-looking scales. Depending upon whether the tuberculous material was more or less crushed in seeding and whether it was brought into contact with a large surface of the medium by rubbing motions, the colonies surround the explanted bit of tissue in smaller or larger areas. If only very few bacilli were present in the inoculum it is hardly possible to free the bacilli from the tissue and bring them into immediate contact with the medium. In this case the colonies develop in the fragments of explanted tissue; and one sees, if the tissue is transparent enough (for example, in bits from scrofulous lymph nodes), dark points in transmitted light and white points in direct light.

With the aid of a 30- to 40-times magnification one can perceive the bacterial colonies as soon as toward the end of the first week. They appear as very neat spindle- and usually S-shaped or similarly curved formations, which consist of the well-known most tenuous bacilli when spread on a cover-slip, and stained and examined with high magnifications. Up to a certain degree their growth proceeds for a period of three to four weeks, as they enlarge to flat scale-like bits, usually not reaching the size of a poppy seed, and lie loosely on the medium, which they never invade or liquefy. Furthermore, the bacillary colony forms such a compact mass that its small scale can easily be removed with platinum wire from the solidified blood-serum as a whole, and can be crushed only upon the application of a certain pressure. The exceedingly slow growth which can be obtained only at incubator temperature, and the peculiar scale-like dry and firm texture of these bacillary colonies are not met with in any other known bacterial species, so that it is impossible to confuse cultures of tubercle bacilli with those of other bacteria; and, even with but little experience, nothing is simpler than to recognize accidental contaminations of the cultures immediately.

As mentioned, the growth of the colonies is finished after a few weeks; and a further enlargement does not occur, because the bacilli are devoid of any intrinsic motility, and because they are moved along the medium only by the process of growth, which, on account of the slow multiplication of the bacilli, may, of course, occur within very small dimensions only.

In order to keep such a culture going, it is necessary to transplant it to a new medium some time after the first seeding, approximately after 10 to 14 days. This is done by removing a few scales with the flamed platinum wire and by transferring these into a fresh test-tube of sterilized coagulated blood-serum, where they are crushed on the surface of the medium and spread as widely as possible. Within the same interval there again develop scale-like, dry masses, which coalesce and, depending upon the extent of their seeding, cover a larger or smaller part of the surface of the blood-serum. In this manner are the cultures continued.

The tubercle bacilli can also be cultivated on other nutritive media, provided the latter possess properties similar to those of the solidified blood serum. For example, they grow on agar-agar, which remains solid at incubator temperature and which contains an addition of meat infusion and peptone. But on this medium there take form only amorphous small crumbs, and never, as on blood-serum, the characteristic vegetations.

Originally I cultivated tubercle bacilli from only the pulmonary tubercles of guinea pigs that had been infected with tuberculous material. Accordingly, the cultures derived from various sources had to pass a sort of intermediary stage, namely, in the body of a guinea pig. This method could, however, have led to the same errors as accompanied the transfer of a culture from one test-tube to another if, accidentally, other bacteria had been inoculated with the tubercle bacilli, or if, as is not rare, spontaneous tuberculosis had occurred in the experimental animal.

To avoid these sources of error, special precautions were necessary; they were derived from observations of the behavior of spontaneous tuberculosis, which endangered these experiments most. Among hundreds of recently bought guinea pigs, which were autopsied in the course of other experiments, I have not found a single tuberculous one. Spontaneous tuberculosis occurred only in single instances and never before three or four months after the animal had been kept in the same room with tuberculous animals. In spontaneously tuberculous animals the bronchial lymph nodes were without exception excessively enlarged and purulent, while in most cases the lungs contained a large caseous focus with far advanced central necrosis, so that several times there had occurred true cavity-formation, as in human lungs. The development of tuberculosis was much slighter in the abdominal organs than in the lungs. The swelling of the bronchial lymph nodes and the beginning of the process in the respiratory organs leave no doubt that spontaneous tuberculosis of these animals is an inhalation infection, that originates from the invasion of a few or possibly only a single infectious germ and which therefore develops very slowly. Inoculation tuberculosis behaves quite differently.

The site of inoculation was in the abdomen near the inguinal lymph nodes. These swelled first, and so presented an early and unmistakable sign of a successful inoculation. The tuberculosis proceeded much more rapidly than does spontaneous tuberculosis, because a larger amount of infectious material was involved, and at autopsy the spleen and liver were found more tuberculous than the lungs. It is therefore not at all difficult to differentiate spontaneous tuberculosis from inoculation tuberculosis in the experimental animal. Considering all these conditions, it could well be assumed that, if several recently bought guinea pigs, inoculated in the same manner and with the same material and kept in separate cages removed from other animals, all simultaneously and after a brief period developed inoculation tuberculosis in the characteristic fashion, then the occurrence of the tuberculosis was caused by the action of the inoculated material.

Events proceeded in the indicated manner; and with all precautions (disinfection of the site of inoculation, use of flamed instruments) the substance to be tested for its virulence was inoculated each time into from four to six guinea pigs. The result was uniform throughout: in all animals which were inoculated with fresh material containing tubercle bacilli the slight inoculation wound was usually scabbed on the following day, and the site remained unchanged for about eight days. Then a nodule formed, which enlarged without rupturing or, in most cases, developed into a flat and dry ulcer. After two weeks the inguinal lymph nodes on the side of inoculation, and sometimes also the axillary nodes, were already swollen to pea size. From this time on, the animals became emaciated rapidly, and died after four to six weeks; or they were killed, in order to exclude any possible combination with a later-developing spontaneous tuberculosis. In the organs of all these animals, but chiefly in the spleen and liver, were found the characteristic and well-known tuberculous alterations. That the infection of the guinea pigs in this procedure was caused only by the inoculated material is evident from the fact that, in several experimental series, the inoculation of material which did not contain living tubercle bacilli did not produce tuberculosis in a single inoculated animal. The material used in these series consisted of a scrofulous lymph node and fungoid masses from a joint, in both of which no tubercle bacilli were demonstrable, and pulmonary tubercles from a monkey, dried for two months and in another case kept in alcohol for two months. Without exception, animals injected with bacilliferous material had far-advanced tuberculosis, four weeks after inoculation.

From such guinea pigs as were infected with tubercles from the lungs of apes, with miliary tubercles from the brain and lungs of human beings, with caseous materials from phthisical[3] lungs, and with nodules from the lungs and the peritoneum of cattle with *Perlsucht,* cultures of tubercle bacilli were isolated in the manner described above. It became evident that, just as the picture of the disease is the same, whether produced by all the enumerated different substances, so do the bacilliary cultures obtained differ not in the slightest from one another. Altogether, there were secured fifteen such pure cultures of tubercle bacilli, four from guinea pigs infected with tuberculous products from a monkey, four from guinea pigs infected with *Perlsucht* material, and seven from guinea pigs infected with tuberculous formations from human beings.

In order to exclude the possible criticism that the inoculation of tuberculous material into guinea pigs causes an alteration, or possibly a disappearance, of the differences characterizing the previously different microorganisms, an attempt was made to cultivate the tubercle bacilli directly from the spontaneously tuberculous organs of human beings and animals.

This attempt succeeded repeatedly, and pure cultures were obtained from two human lungs with miliary tuberculosis, from a human lung with caseous pneumonia, from the contents of small cavities in phthisical lungs twice, from caseated mesenteric lymph nodes once, and from specially excised scrofulous lymph nodes twice; further, twice from pulmonary *Perlsucht* in cattle, and three times from the lungs of spontaneously diseased guinea pigs. These cultures likewise resembled one another completely, as did those, which were obtained by the intermediation of inoculated guinea pigs, so that the identicalness of the bacilli present in various tuberculous processes cannot be doubted.

In regard to these pure cultures I must mention that Klebs, Schüller, and Toussaint have also cultivated microorganisms from tuberculous masses. All three investigators found that, after their infection with tuberculous material, the nutritive-media fluids became cloudy as early as within two to three days, and contained numerous bacteria. In Klebs's experiments small motile rods developed rapidly, while Schüller and Toussaint obtained micrococci. I have convinced myself repeatedly that tubercle bacilli grow only very sparsely in liquids, that they never cloud the latter because they are totally nonmotile and that, if growth occurs, it becomes recognizable only after three or four weeks. The authors mentioned must therefore have dealt with organisms other than tubercle bacilli.

Up to this point it was established by my studies that the occurrence of characteristic bacilli is regularly coincidental with tuberculosis and that these bacilli can be obtained and isolated in pure cultures from tuberculous organs. It remained to answer the important question whether the isolated bacilli when again introduced into the animal body are capable of reproducing the morbid process of tuberculosis.

In order to exclude every error in the solution of this question, which contains the principal point in the whole study of the tubercle virus, many different series of experiments were done, which, on account of the significance of the point at issue, will be enumerated.

First, were done experiments involving the simple inoculation of bacilli in the previously described manner.

First Experiment: Of six recently bought guinea pigs which were kept in the same cage, four were inoculated on the abdomen with bacillary culture material derived from human lungs with miliary tubercles and grown in five transfers for fifty-four days. Two animals remained uninoculated. In the inoculated animals the inguinal lymph nodes swelled after fourteen days, the site of inoculation changed into an ulcer, and the animals became emaciated. After thirty-two days one of the inoculated animals died, and after thirty-five days the rest were killed. The inoculated guinea pigs, the one that had died spontaneously as well as the three killed ones, showed far-advanced tuberculosis of the spleen, liver and lungs; the inguinal nodes were much swollen and caseated; the bronchial lymph nodes were but little swollen. The two non-inoculated animals displayed no trace of tuberculosis in lungs, liver or spleen.

Second Experiment: Of eight guinea pigs, six were inoculated with bacillary culture material, derived from the tuberculous lung of an ape, and cultivated in eight transfers for ninety-five days. Two animals remained uninoculated as controls. The course was exactly the same as in the first experiment. At autopsy the six inoculated animals were found with far advanced tuberculosis, while the two non-inoculated ones were healthy when they were killed, after thirty-two days.

Third Experiment: Of six guinea pigs, five were inoculated with culture material, derived from a *Perlsucht* lung, and seventy-two days old and transferred six times. After thirty-four days all animals were killed. The five inoculated ones were tuberculous, the non-inoculated one was healthy.

Fourth Experiment: A number of animals (mice, rats, hedgehogs, hamsters, pigeons, frogs), whose susceptibility to tuberculosis is not known, were inoculated with cultures derived from the tuberculous lung of a monkey which had been cultivated for 113 days outside the animal body. Four field mice, killed 53 days after the inoculation, had numerous tubercles in the spleen, liver and lung; a hamster, killed 53 days after inoculation, showed the same result. In these four experiments the inoculation of bacillary cultures on the abdomen of the experimental animals had, then, produced exactly the same kind of inoculation tuberculosis as if fresh tuberculous materials had been inoculated. In the next experiment the inoculum was introduced into the anterior chamber of rabbits' eyes, in order to find out whether, in the so modified inoculation method, the same effect would be obtained by the artificially cultivated tubercle virus as with the natural virus.

Fifth Experiment: Three rabbits were inoculated with a small crumb of a culture (derived from a caseous pneumonia in a human lung and cultivated for 89 days) in the anterior ocular chamber. An intense iritis developed after a few days, and the cornea soon became clouded and discolored to a yellowish-gray. The animals rapidly became emaciated. They were killed after 25 days and their lungs were found studded with countless tubercles.

Sixth Experiment: Of three rabbits, one received an injection of pure blood-serum into the anterior chamber of the eye, and the two others an injection of the same blood-serum; in which, however, a small crumb of a culture (originating from a lung with *Perlsucht* and cultivated 91 days) had been suspended. In the latter two rabbits, the same phenomena occurred as in the preceding experiment—rapidly progressing iritis and clouding of the cornea. After 2 days the animals were killed. The first rabbit, injected with pure blood-serum, was completely healthy, while the lungs of the other two were studded with innumerable tubercles.

Seventh Experiment: Of four rabbits, the first received pure blood-serum in the anterior eye chamber; in the case of the second the needle, which contained blood-serum with a bacillary culture (from monkey tuberculosis, cultivated 132 days), was introduced into the anterior chamber of the eye, but the plunger was not moved, so that only a minimal amount of the fluid could get into the aqueous humor. The third and fourth rabbits were injected in the anterior chamber with several drops of the blood-serum with bacillary culture. Iritis and panophthalmitis developed in the latter two animals, and very rapid emaciation followed. In the case of the second rabbit, on the other hand, the eye remained at first unchanged, but in the course of the second week single whitish yellow nodules appeared on the iris near the site of the puncture, and there developed, growing out from this center, a typical tuberculosis of the iris. New nodules kept forming on the iris, which became wrinkled, while the cornea clouded slowly and the further changes were obscured to further observation. After 30 days these four animals were killed. The first was entirely healthy; in the second, besides the formerly noted changes in the eye, the lymph nodes near the mandible and beside the root of the ear were swollen and studded with yellowish-white foci. The lungs and the other organs were still free from tuberculosis. The two latter rabbits, again, had countless tubercles in the lungs.

Eighth Experiment: Six rabbits were infected in the same manner as in the preceding experiment, using culture from a human lung with miliary tuberculosis, which had been cultivated 105 days. The second animal was infected only by a prick in the anterior chamber of the eye, without injection. All six developed tuberculosis of the iris, while some developed also a slowly spreading infiltration with tubercles on the conjunctiva near the site of inoculation. The results of these experiments with inoculation into the anterior eye chamber, when as small a number of tubercle bacilli as possible was introduced, corresponded entirely with those obtained by Cohnheim and Salomonsen, and Baumgarten. I did not content myself with this, but began further experiments, comprising injections of bacillary cultures into the abdominal cavity or directly into the blood stream, and attempted, finally, to make tuberculous, with the artificially grown virus, such animals whose infection with tuberculosis was not easily accomplished.

Ninth Experiment: Of 12 guinea pigs, 10 were injected in the abdominal cavity with blood-serum containing a bacillary culture, originating from monkey tuberculosis and cultivated 142 days. The eleventh animal was injected with pure blood-serum in the abdominal cavity, while the twelfth, which had a fresh, considerable wound from a bite on the abdomen, was not injected. The animals injected died on the 10th, 13th, 16th, 17th and 18th days respectively. On the 25th day, the remainder, together with the control animals, were killed. Of those that died first, the omentum was markedly thickened and rolled together, and was infiltrated with a firm, yellowish mass. Under the microscope, this mass was seen to be composed of countless tubercle bacilli, almost all of which had very definite spores. Those that died later and also the killed animals of this group had already had, in addition to the infiltration of the omentum, eruptions of tubercles in the spleen and liver. The control animals were found entirely healthy.

Tenth Experiment: A number of white rats were fed for two months almost entirely with the bodies of tuberculous animals. From time to time one was killed and examined. A few times a few single small gray nodules were found in the lungs of these animals, but the majority remained entirely healthy. Also, simple inoculation with tuberculous substances and with cultures from these substances had no effect on these animals, although such inoculations were repeatedly done. After the feeding with tuberculous masses had been stopped for several weeks, five of these rats received an intraperitoneal injection of bacillary culture (from monkey tuberculosis, cultivated 142 days). Five weeks later these animals were killed, and in the lungs, as well as in the much-enlarged spleen, countless tubercles were found. This experiment is not clear-cut, since the feeding with tuberculous masses had been done before, but I refer to it because it was successful in creating a typical tuberculosis through the injection of bacillary culture, in rats, which are as resistant to all infectious material as dogs.

Eleventh Experiment: Of 12 rabbits, two received 0.5 cc. of pure blood-serum in the ear vein. Four rabbits received in the same manner blood-serum with culture (originating from monkey tuberculosis and cultivated 178 days). Three rabbits were injected with culture from a phthisical human lung, cultivated 103 days, and the last three received blood-serum with culture from a *Perlsucht* lung, cultivated 121 days. For each of these groups a separate syringe was used. The first two rabbits remained lively and strong, but all the rest grew thin rapidly and began to breathe with difficulty in the second week. The first animal died after 18 days (injection with culture from phthisical lung); the second and third (both had received culture from monkey tuberculosis) after 19 days; the fourth (injection with culture from *Perlsucht*) after 21 days; the fifth (infected with culture from phthisis) after 25 days; the sixth and seventh (infected with culture from monkey tuberculosis) after 26 and 27 days; and on the thirtieth and thirty-first days two more animals died. The last animal and the two controls were killed on the thirty-eighth day after the injection. No difference could be discerned in the lung and the rest of the organs of the animals infected with different cultures. Countless miliary tubercles were found in the lungs of all the animals. The livers and spleens of all these animals also contained remarkably numerous tubercles, but these were, in the case of those that died first, microscopic in size; in the case of those that died later, the tubercles had developed so far as to be visible macroscopically; and one rabbit showed many miliary tubercles visible to the naked eye also in the omentum, the diaphragm and the mesentery as well. The two control animals were found at autopsy to be without deposit of tubercles in any organ whatever.

Twelfth Experiment: Two strong, full-grown cats received an injection in the abdominal cavity with blood serum, which had been triturated with a culture from monkey tuberculosis, cultivated for 162 days. One died in 19 days. The omentum was infiltrated with a firm whitish mass, and was more than a centimeter thick in places. The serous lining of the intestines and peritoneum had lost its luster; the spleen was much enlarged. The infiltration of the omentum consisted (just as in the case of the guinea pigs that had received an injection with bacillary culture in the abdominal cavity) of densely packed tubercle bacilli, for the most part embedded in cells. There was as yet no macroscopically visible eruption of tubercles; but, microscopically, countless tubercles were visible in the lungs, liver and spleen. The second cat was killed after 43 days, and numerous tubercles, of the size of a millet-seed, were found in the lungs, spleen and omentum, with relatively few in the liver.

Thirteenth Experiment: Two cubic centimeters of blood-serum, mixed with culture from human miliary tuberculosis, which had been cultivated 94 days, was injected into the abdominal cavity of a bitch several years old. No change was visible in the animal during the first two weeks after the injection; then she lost spirits, ate less, and, from the end of the third week on, she showed a definite distention of the abdomen. At the beginning of the fifth week she was killed. A fairly massive, clear, pale exudate was found in the abdominal cavity. The omentum, mesentery and the round ligaments were studded with many tubercles, as were also the surfaces of the intestines and the bladder. The enlarged spleen, the liver and the lungs contained innumerable miliary tubercles. The site of injection was not recognizable, and there was no trace of caseous pus. It is scarcely necessary to mention that the syringes used in all these experiments were always safely disinfected before use, through heating for one hour at a temperature of 160° to 170°C. The tubercles obtained by inoculation or injection of bacillary cultures were examined microscopically many times, and found entirely identical with the ordinary tubercles formed in the same animal species spontaneously or after infection with tuberculous masses. They had absolutely the same arrangement of cellular elements, and frequently contained giant cells which, just as in the case of the spontaneous tubercles, en-closed bacilli. Furthermore, from these tubercles, which were derived by means of the bacillary culture, the bacilli were again isolated in pure culture, and with these, as well as with the tubercles, inoculation experiments were done, which had entirely the same result as infection with human tubercles or with *Perlsucht*. Therefore, in this regard also, the tubercles obtained through infection with cultures behaved like those occurring naturally.

Looking back on these experiments, it is seen that a not inconsiderable number of experimental animals that received the bacillary cultures in very different ways—namely, through abdominal cavity or the anterior chamber of the eye, or directly into the blood-stream—became tuberculous without exception. Not only were single nodules formed, but the extraordinary number of tubercles was in proportion to the large number of bacilli introduced. It was successful with other animals, through infection in the anterior ocular chamber with as small a number of bacilli as possible, to give rise to the very same tuberculous iritis as in the well known experiments of Cohnheim and Salomonsen, and Baumgarten, which were so decisive on the question of inoculation tuberculosis and which were performed with true tuberculous material only.

A confusion with spontaneous tuberculosis, or a chance undersigned [*sic*] infection with tuberculous virus is impossible in these experiments for the following reasons: In the first place, neither a spontaneous tuberculosis nor a chance infection could cause such massive eruptions of tubercles in so short a time. In the second place, the control animals, which were treated in exactly the same way as the infected animals, with only the single difference that they received no bacillary culture, remained healthy. In the third place, in the case of numerous guinea pigs and rabbits, infected and injected with other substances in the same way, for other purposes of research, there never occurred this typical picture of miliary tuberculosis, which can only exist when the body is suddenly overwhelmed with a large number of bacilli.

All these facts, taken together, justify the statement that the bacilli present in tuberculous substances are not only coincidental with the tuberculous process, but are the cause of the process, and that we have in the bacilli the real tuberculous virus.

This establishes the possibility of defining the boundaries of the diseases to be understood as tuberculosis, which could not be done with certainty until now. A definite criterion for tuberculosis was lacking. One author would reckon miliary tuberculosis, phthisis, scrofulosis, *Perlsucht*, etc., as tuberculosis; another would hold, perhaps with quite as much right, that all these morbid processes were different. In future it will not be difficult to decide what is tuberculous and what is not tuberculous. The decision will be established, not by the typical structure of the tubercle, nor its avascularity, nor the presence of giant cells, but by the demonstration of tubercle bacilli, whether in the tissues by staining-reactions or by culture on coagulated blood-serum. Taking this criterion as decisive, miliary tuberculosis, caseous pneumonia, caseous bronchitis, intestinal and lymph-node tuberculosis, *Perlsucht* in cattle, spontaneous and infectious tuberculosis in animals, must, according to my investigations, be declared identical. My investigations of scrofulosis and fungoid joint affections are not numerous enough to make a decision possible. In any event, a large number of scrofulous lymph nodes and joint affections belong to true tuberculosis. Perhaps they belong entirely to tuberculosis. The demonstration of tubercle bacilli in the caseated lymph node of a hog, or in the tubercles of a hen, permits the inference that tuberculosis has a wider dissemination among domestic animals than is commonly supposed. It is very desirable to learn exactly the distribution of tuberculosis in this respect.

Since the parasitic nature of tuberculosis is proved, it is still necessary for the completion of its aetiology to answer the questions of where the parasites come from and how they enter the body.

In regard to the first question it must be decided whether the infectious materials can propagate only under such conditions as prevail in the animal body or whether they may undergo a development independent of the animal organism, somewhere in free nature, such as, for example, is the case with anthrax bacilli.

In several experiments it was found that the tubercle bacilli grow only at temperatures between 30° and 41°C. Below 30° and above 42° not the slightest growth occurred within three weeks, while anthrax bacilli, for example, grow vigorously at 20° and between 42° and 43°C. The question mentioned can already be decided on the basis of this fact. In temperate climates there is no opportunity offered outside the animal body for an even temperature of above 30°C of at least two weeks' duration. It may be concluded that, in their development, tubercle bacilli are dependent exclusively upon the animal organism; that they are true and not occasional parasites; and that they can be derived only from the animal organism.

Also the second question, as to how the parasites enter the body, can be answered. The great majority of all cases of tuberculosis begin in the respiratory tract, and the infectious material leaves its mark first in the lungs or in the bronchial lymph nodes. It is therefore very likely that tubercle bacilli are usually inspired with the air, attached to dust particles. There can hardly be any doubt about the manner by which they get into the air, considering in what excessive numbers tubercle bacilli present in cavity-contents are expectorated by consumptives and scattered everywhere.

In order to gain an opinion about the occurrence of tubercle bacilli in phthisis sputum I have examined repeatedly the sputum of a large series of consumptives and have found that in some of them no bacilli are present, and that, however, in approximately one-half of the cases, extraordinarily numerous bacilli are present, some of them sporogenic. Incidentally, it may be remarked that, in a number of specimens of sputum of persons not diseased with phthisis, tubercle bacilli were never found. Animals inoculated with fresh bacilliferous sputum become tuberculous as certainly as following inoculations with miliary tubercles.

Also, such infectious sputa did not lose their virulence after drying. Four guinea pigs were inoculated with two-weeks-old dried sputum, and four guinea pigs with sputum kept in the same way for eight weeks; they all became tuberculous in the same manner as following infection with fresh material. It can therefore be assumed that phthisical sputum dried on the floor, clothes, etc., retains for a considerable time its virulence, and that, if it enters the lung in a pulverized state, it can produce tuberculosis there. Presumably the durability of its virulence is dependent upon the spore-formation of the tubercle bacilli, and it must be considered in this regard that the spore-formation, as we have seen in several examples, occurs already in the animal organism, and not, as in anthrax bacilli, outside of it.

It would lead too far into the realm of hypothesis to attempt to discuss here the conditions of acquired and inherited disposition, which undoubtedly play a significant role in the aetiology of tuberculosis. In this connection thorough studies are still required before a judgment is warranted. I wish to draw attention only to one point, which may serve as explanation for many puzzling phenomena: that is, the exceedingly slow growth of the tubercle bacilli. This is most probably the reason why the bacilli cannot infect the body through every little wound in such a way as do the unusually fast-growing anthrax bacilli. If one wishes to render an animal tuberculous with certainty, the infectious material must be brought into the subcutaneous tissue, into the peritoneal cavity, into the ocular chamber; in brief, into a place where the bacilli have the opportunity to propagate in a protected position and where they can focalize. Infections from superficial skin wounds not penetrating into the subcutaneous tissue, or from the cornea, are only exceptionally successful. The bacilli are eliminated again before they are able to implant themselves.

This explains why autopsies on tuberculous bodies do not cause infection, even when small cuts on the hand come in contact with tuberculous masses. Small superficial cuts are not suitable inoculation wounds for the invasion of bacilli. Similar conditions prevail probably for the implantation of bacilli which have reached the lungs. It is probable that certain peculiar factors favoring the implantation of bacilli, such as stasis of secretions, desquamation of epithelium, etc., must aid to make infection possible. It would be hardly understandable otherwise that tuberculosis is not much more frequent than it really is, since practically everybody, particularly in densely populated places, comes more or less in contact with tuberculosis.

If we ask further what significance belongs to the results gained in this study of tuberculosis it must be considered a gain for science that it has been possible for the first time to establish the complete proof of the parasitic nature of a human infectious disease, and this of the most important one. So far such proof was established only for anthrax, while in a number of other infectious diseases in human beings, for example, relapsing fever, wound infections, leprosy, gonorrhea, it was only known that parasites occur simultaneously with the pathological process, but the causal connection between the two has not been established. It may be expected that the elucidation of the aetiology of tuberculosis will provide new viewpoints for the study of other infectious diseases, and that the research methods which have stood the test in the investigation of the aetiology of tuberculosis will be of advantage for the work in other infectious diseases. Quite particularly may this hold true for studies of those diseases, which, like syphilis and glanders,[4] are most closely related to tuberculosis, and form with it the group of infectious tumors.

How far pathology and surgery can utilize the knowledge about the properties of the tuberculosis parasite it is not my duty to define. It remains to be seen whether, for example, the demonstration of tubercle bacilli in the sputum can be used for diagnostic purposes, or whether the certain diagnosis of many localized tuberculous affections will be of influence in their surgical treatment, and whether therapy may profit from further experiences about the living conditions of the tubercle bacilli. My studies have been done in the interest of public health, and I hope that this will derive the largest profit from them.

Tuberculosis has so far been habitually considered to be a manifestation of social misery, and it has been hoped that an improvement in the latter would reduce the disease. Measures specifically directed against tuberculosis are not known to preventive medicine. But in future the fight against this terrible plague of mankind will deal no longer with an undetermined something, but with a tangible parasite, whose living conditions are for the most part known and can be investigated further. The fact that this parasite finds the conditions for its existence only in the animal body and not, as with anthrax bacilli, also outside of it under usual, natural conditions, warrants a particularly favorable outlook for success in the fight against tuberculosis. First of all, the sources from which the infectious material flows must be closed as far as this is humanly possible. One of these sources, and certainly the most essential one, is the sputum of consumptives, whose disposal and change into a harmless condition has thus far not been accomplished. It cannot be connected with great difficulties to render such phthisical sputum harmless by suitable procedures of disinfection, and to eliminate thereby the largest part of the infective tuberculous material. Besides this, the disinfection of clothes, beds, etc., which have been used by tuberculous patients, must certainly be considered.

Another source of infection with tuberculosis is undoubtedly tuberculosis of domestic animals, in the first rank, *Perlsucht*. Herewith, too, is indicated the position which public health has to assume in future on the question of the danger of meat and milk from animals with *Perlsucht*. *Perlsucht* is identical with tuberculosis in man, and is therefore a disease transmissible to man. It must therefore be treated exactly the same way as other diseases transmissible from animals to man. Be the danger of meat and milk from animals with *Perlsucht* ever so great or ever so little, it is present, and it must therefore be avoided. It is sufficiently known that anthrax-infected meat has been eaten by many persons, and often for a long time, and without any ill effects, and still no one will conclude there from that the trade in such meat should be permitted.

In regard to milk from cows with *Perlsucht* it is noteworthy that the extension of the tuberculous process to the mammary gland has been observed not rarely by veterinarians, and it is therefore quite possible that in such cases the tuberculous virus may be mixed directly with the milk.

Still further viewpoints might be mentioned in regard to measures which could serve to limit the disease on the basis of our present knowledge of the aetiology of tuberculosis but the discussion here would lead too far. When the conviction that tuberculosis is an exquisite infectious disease has become firmly established among physicians, the question of an adequate campaign against tuberculosis will certainly come under discussion and it will develop by itself.

Sources

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On Bacteriological Research
(1890)

The honor of being invited to deliver a lecture[1] to the International Congress confronted me with a decision. Should I lecture on hygiene, the science with which I am currently most occupied, or on bacteriology, the science to which I devoted myself almost exclusively in earlier years? I decided upon the latter because bacteriology still claims the most general interest. Consequently, I will depict briefly the current position of some of the more important aspects of bacteriology. Certainly those who are familiar with bacteriology will find nothing new in these remarks. In order not to appear completely empty-handed to these persons, however, I intend to include a few unpublished remarks regarding my continuing studies of tuberculosis.

At least as it concerns us physicians, bacteriology is a very young science. Fifteen years ago one knew only that in anthrax and in relapsing fever, characteristic foreign structures appeared in the blood, and that in diseases involving infected wounds so-called vibrions sometimes appeared. It had not yet been proved that they were the causes of these diseases, and except for a few investigators who were generally thought of as visionaries, these phenomena were more often regarded as curiosities than as causes of disease. One could not think otherwise; it had not yet been proved that they were independent beings specific to these diseases. In decaying liquids, namely in the blood of slaughtered animals, one found bacteria that could not be distinguished from anthrax bacteria. A few investigators would not admit that they were even alive, but took them to be crystalline. They claimed that bacteria identical to the relapsing fever spirillum could be found in swamp water and in tooth slime, and that bacteria identical to the micrococci of wound infections could be found in healthy blood and tissues.

No progress could be made with available experimental and optical technology. Things would have remained in this state except that just then new methods of investigation became available. Suddenly circumstances changed completely, and it became possible to further penetrate this dark realm. By the expeditious use of improved lens systems, and with the support of aniline dyes, even the smallest bacteria became clearly visible and morphologically distinguishable. Simultaneously, the use of culture media, which could be rendered either liquid or solid, made it possible to separate single germs and to obtain pure cultures. The unique characteristics of each individual species could thereby be determined with certainty. It soon became clear what this new technology could achieve. Several well-characterized new species of pathogenic microorganisms were discovered, and what was particularly important, the causal relation between these and the corresponding diseases was demonstrated. Because all the disease agents that were discovered were bacteria, it began to appear as though the infectious diseases were caused exclusively by distinguishable species of bacteria. One could also hope that within a short time the disease agents for all the contagious diseases would be found. This expectation has not been fulfilled, and subsequent investigations of bacteria have also taken other unexpected turns.

Restricting myself first to the positive results of bacteriology, I would like to emphasize the following points:

It has been fully proved that the bacteria, exactly like higher plants, constitute species that are fixed but difficult to demarcate from one another. Until a few years ago, it was resolutely insisted—and it is yet maintained by a few investigators—that species of bacteria were mutable in a way that no other species of living beings were, that at different times they could adopt totally different morphological or biological characteristics, and that one could assume the existence of at most a few species. It was also held that bacteria were not independent organisms, but that they were part of the life cycle of molds, or, as some maintained, that they were among the lower algae. Others espoused the view—even less compatible with the independent existence of the bacteria—that they were by-products of animal cells, for example, of blood corpuscles. All of these opinions are untenable given the accumulation of overwhelming evidence that invariably shows that we are dealing with species that can be well characterized. The oldest medical writers described in unmistakable detail such bacterial infectious diseases as leprosy and tuberculosis. Even this shows that the pathogenic bacteria are much more likely to retain their characteristics over a long period of time than to change quickly as it is often assumed after a consideration of various mutable epidemic diseases.

Of course, within certain limits bacteria, especially pathogenic bacteria, can depart from their ordinary types. But in this respect bacteria do not differ from the higher plants in the smallest respect. These can also be variously changed, usually in response to external influences, and we then speak of varieties even though the species must be regarded as unchanged. Thus, under conditions unfavorable to development, a species of bacteria can produce atrophied forms. Certain characteristics that are particularly apparent or that are of special interest to physicians, but that may be of little importance in the total life of the plant, for example, the creation of a pigment, the capacity to grow within living animal bodies, or the generation of certain poisons, may also be temporarily or, insofar as it comes within our experience, totally lost. These are only changes within certain limits. They never involve such departures from type as would be necessary for a new species to be created or for one species to be converted into another, for example, for anthrax bacilli to be converted into hay bacilli.

In contrast to the higher plants, the bacteria are too small to provide morphological characteristics that are effective and useful for classifying. Thus, in identifying species we cannot rely on a single characteristic—indeed for any such characteristic one may not know in advance whether it is among the fixed or the mutable qualities of the species. Rather we must conscientiously collect as many morphological and biological features as possible, even if they seem to be unimportant, and the species must be determined by considering all of these. In this respect, one simply cannot go too far; many misunderstandings and contradictions have occurred in bacteriology because of inadequate concern for this rule.

Typhoid bacilli provide a very characteristic example of the difficulties that must be overcome in determining species. If they are encountered in the mesenteric glands, in the spleen, or in the liver of a typhoid corpse, there is never a doubt that they are genuine. In these places no other bacteria have been observed that can be confused with them. However, circumstances are quite different if one wishes to demonstrate the presence of the bacilli in the contents of the intestines, in the soil, in water, or in airborne dust. There one finds numerous very similar bacilli that can be distinguished from the typhoid bacillus only by experienced bacteriologists and even then without certainly, because constant and unmistakable criteria are lacking. Recent claims that typhoid bacteria have been found in the earth, in water mains, and in food must, therefore, be regarded with skepticism. The situation is similar with respect to diphtheritic bacteria. Fortunately, other important pathogenic bacteria, as for example tuberculosis and cholera bacilli, possess such reliable features that they can always be recognized even in the most difficult circumstances. The great advantages provided by the certain diagnosis of the disease agents in these cases constitute an urgent imperative to ignore earlier failures and to seek, from the beginning, similarly reliable characteristics for typhoid, diphtheria, and the other important pathogenic bacteria. In no other way will it be possible to trace the hidden and contorted pathways of these disease agents outside the body, and so to achieve a firm foundation for rational prophylaxis.

However, in dealing with tuberculosis I have discovered how careful one must be in judging criteria for differentiating even the most well-known species of bacteria. This species is known by its resistance to dyes, its tendency to vegetate in pure culture, and it pathological characteristics. It is so precisely characterized by each of these qualities that is appears absolutely impossible to confuse it with other bacteria. Even so, in identification one must not rely on any one of these characteristics. Rather, one must follow the rule mentioned above; one must consider all the available characteristics. Only after they are all in accordance, has the identity of the bacillus been proved. As I began my first investigation of tuberculosis bacilli, I felt obliged to hold strictly to this rule. Consequently, tuberculosis bacilli of various origins were not only tested for their resistance to dyes, but also for their vegetative properties in pure culture, and for their pathogenicity. Only in respect to tuberculosis of chickens was it impossible to carry this out; at that time it was not possible for me to obtain fresh material from which I could grow a pure culture. However, because all the other varieties of tuberculosis produced identical bacilli and because the bacillus for chicken tuberculosis appeared identical and had an identical reaction to aniline dyes, I concluded that they were identical in spite of this gap in the investigation. Later I obtained pure cultures from several sources that were supposedly derived from tuberculosis bacilli, but reliable investigators obtained inconsistent results in attempts to infect various animals. These had to be viewed as unexplained contradictions. I first believed that this was the result of changes of the kind that are often observed among pathogenic bacteria when they are maintained for a long time under unfavorable conditions in pure culture outside the body. To solve the riddle I attempted, by various influences, to change ordinary tuberculosis bacilli into the previously mentioned variety. I kept them for many months at so high a temperature that only a stunted growth appeared; in other cases I maintained even higher temperature for so long that the culture nearly died out. I exposed the culture to chemicals, to light, and to dampness; I bred them with other cultures through several generations; and in successive generations I inoculated them into relatively unsusceptible animals. In spite of these interventions, I achieved only minor changes in comparison to those that similar interventions induced in other pathogenic bacteria. It appeared, therefore, that particularly tuberculosis bacteria tenaciously retained their characteristics. This was confirmed by pure cultures that I bred for more than nine years in test tubes without these ever having been placed in a living body. Such cultures remained totally unchanged except for a slight loss of virulence.

After the failure of all attempts to explain these observations, the solution was finally disclosed by a fortunate coincidence. At the end of the year, I happened to receive a few tuberculous chickens. I used this opportunity to correct my previous omission—I took cultures directly from the diseased organs of these animals. As the cultures grew, I saw to my astonishment that they looked exactly like and had all the other characteristics of the mysterious culture that was so similar to true tuberculosis bacteria. Subsequently, it was possible to confirm that the mysterious culture was also from fowl tuberculosis. However, under the assumption that all forms of tuberculosis were identical, the sample was taken as genuine tuberculosis bacilli. This observation was confirmed in investigations on chicken tuberculosis that were conducted and recently published by Professor Maffucci.[2] Chicken tuberculosis is a separate species but one closely related to true tuberculosis. One is immediately confronted by important practical questions such as whether the bacillus of chicken tuberculosis is also pathogenic for humans. This question cannot be answered until bacteria of this kind happen to be found in humans, or until their absence can be confirmed in a sufficiently long series of cases. For this purpose, of course, one cannot rely on reactions to pigments as has previously been done; rather one will need to employ culture experiments in every case.

All new experiences indicate that in demarcating species of bacteria one must proceed with the utmost caution and draw the boundaries for individual varieties too narrowly rather than too widely.

In another important and fundamental area, matters have also become clearer and simpler than in earlier times, namely in respect to demonstrating the causal relation between the pathogenic bacteria and the associated infectious diseases. A few earlier thinkers suggested that microorganisms must cause infectious diseases. But this opinion was not generally accepted and the first discoveries in this area were viewed skeptically. Thus, it was all the more necessary to provide absolutely uncontradictable reasons for concluding that the microorganisms found in a specific disease really were the cause of the disease. At that time, one could still object that the simultaneous occurrence of the disease and of the microorganism was purely accidental, and that the microorganism was not dangerous but only a harmless parasite that found, in the diseased organ, conditions for life that were not provided by the healthy body. Many recognized the pathological characteristics of bacteria but felt that these characteristics originated under the influence of the disease and that this influence could convert harmless microorganisms that were accidentally or even regularly present into pathogenic bacteria. But the microorganism could not be regarded as an accidental concomitant of the disease once it was proved, first, that the parasite was present in every single case of the disease and, indeed, under conditions that corresponded to the pathological changes and to the clinical course of the disease; second, that it never occurred in other diseases as an accidental or non-pathological parasite; and third, that it could be isolated from the body and was capable, in pure culture and often without other nourishment, of generating fresh cases of the disease. Given these facts the only possible relation between the parasite and the disease is that the parasite is the causal agent.

This proof was established in its entirety for a number of infectious diseases, for anthrax, tuberculosis, erysipelas, tetanus, and for various animal diseases, indeed, for nearly all diseases that could be conveyed to animals. In this way it also appeared that whenever one succeeded in establishing the regular and exclusive occurrence of bacteria, they never occurred as accidental concomitants, but only as positively identified pathological parasites. Thus, if the first two conditions of the proof are satisfied, that is, if the regular and exclusive occurrence of the microorganism can be demonstrated, the causal relation between the parasite and the disease is fully established. Under this assumption, we must judge a series of diseases to be parasitic even though we have not been fully successful in infecting experimental animals and thereby in completing the third part of the proof. These diseases include abdominal typhoid, diphtheria, leprosy, relapsing fever, and Asiatic cholera. I want to emphasize especially cholera because the parasitic conception of the disease has been resisted with unusual obstinacy. Every imaginable effort has been made to rob the cholera bacteria of their specific character. But it has victoriously withstood all the assaults; it is now firmly established and universally accepted as the cause of cholera.

These issues are general but, because of their fundamental significance, most important. Bacteriological investigation has also made strides in several other directions in clarifying the relation between pathological bacteria and infectious diseases. It would lead too far astray to investigate this further; it may be sufficient to indicate that we are now, for the first time, in a position to form correct conceptions of how disease materials maintain themselves outside the body in water, soil, and air. These conceptions differ substantially from earlier opinions that were based on uncertain hypotheses. Now, for the first time, we can obtain reliable information about the extent to which disease agents are true parasites, that is, beings that exist exclusively in human or in animal bodies.

These circumstances are decisively important for prophylactic measures against certain diseases such as tuberculosis. Moreover, the means by which disease agents invade the body have been sufficiently determined for some pathogenic bacteria to enable us to form correct conceptions of these processes. Also our knowledge concerning the behavior of the pathogenic bacteria in the interior of the body becomes ever more encompassing; many pathological processes which once seemed mysterious are now more perfectly understood. This includes the frequent occurrence of combinations of various infectious diseases of which one is to be regarded as the primary infection and the others as secondary.

Secondary infections modify the primary disease, they give it an especially dangerous character, or may follow it as subsequent diseases. These conditions are observed especially in smallpox, scarlet fever, diphtheria, cholera, typhoid, and in tuberculosis. There have also been examinations of the metabolic by-products of bacteria. Among these, one finds some that are toxic in characteristic ways. These may have an influence, perhaps the most important influence, on the symptoms of infectious diseases. In this respect, the newly discovered poisonous proteins, the so-called toxic albumins, which can be obtained from anthrax, diphtheria, and tetanus cultures, are particularly interesting.

The related question of the nature of immunity is also being examined with great intensity; this question can also be answered only with the help of bacteriology. As yet there is no complete solution. It had long been believed that this was a purely cellular matter, a kind of battle between the invading parasites and the phagocytes that defend the body. However, this view is losing ground; it is becoming apparent that here too chemistry plays the main role.

In this relatively short time, bacteriological investigation has produced an abundance of information on the biological aspects of the bacteria. Much of this is also of importance for medicine. Thus, enduring forms such as the spores of anthrax and tetanus bacilli, which occur among many bacteria, resist high temperatures and the operation of chemical agents, a resistance that is unparalleled in other forms of life. Also many results have been obtained from investigations of the influence of such factors as warmth, cold, drying, and chemical substances on those pathogenic bacteria that do not form spores. These results are of value in prophylaxis.

Of these factors, light appears to be among the most important. It has been known for several years that direct sunlight kills bacteria rather quickly. I can confirm this for tuberculosis bacteria, which are killed by direct sunlight within a few minutes to a few hours depending on the thickness of the covering under which they are placed. It seems particularly noteworthy that diffused daylight exercises a similar, if significantly slower, influence. Tuberculosis cultures die in five to seven days when placed near a window.

For the etiology of the infectious diseases it is also important that all bacteria can multiply only in moist conditions, thus, in the vicinity of water or of other suitable fluids. It is also important that they are not able on their own to enter the air from moist surfaces. Consequently, pathogenic bacteria can be carried in the air only as dust or on dust particles. Only those that can live for a long time in a dried form can be carried by air currents. But they can never multiply in the air itself as had once been assumed.

In all these areas, the study of bacteriology has fulfilled or even surpassed everything that it seemed to promise at its inception. In other areas, however, it has fallen short of expectations. In spite of improved staining techniques and lens systems, no more has been discovered about the inner structure of bacteria than was disclosed by the original methods. Only most recently have new staining methods promised to reveal more about the structure of bacteria. One can now differentiate more clearly the nucleus from the outer cell wall and the organs of movement, the flagella, that radiate from the cell wall.

In many areas, however, indeed precisely where one would least have expected it, bacteriological investigation has been of no avail. This has been the case in the study of several infectious diseases which, because of their pronounced infectiousness, appeared to be easy objects of investigation. This applies especially to the exanthemata—measles, scarlet fever, smallpox, and exanthematic typhoid. In none of these cases has there been the slightest success in identifying disease agents. Similarly, although vaccines are readily available and can easily be tested on animals, we have not discovered their active principle.

The same holds true of rabies. We also know nothing about the disease agents of influenza, whooping cough, trachoma, yellow fever, *Rinderpest*,[3] *Lungenseuche*,[4] and many other undoubtedly infectious diseases. The negative results of the efforts of numerous researchers can only mean that the methods of investigation, which until now have proved themselves in so many cases, no longer suffice. I suspect that these diseases involve organized disease agents that are not bacteria but rather belong to completely different groups of microorganisms. This opinion is all the more justified by the recent discovery that the blood of many animals—as for example the blood of malaria victims—contains the unique animal parasites known as protozoa. Of course, as yet one can do not more than demonstrate the presence of these noteworthy and important parasites. Apparently, no further progress will be made until protozoa, like bacteria, can be grown in an artificial medium or under natural conditions outside the body. Only then will one be able to study the conditions under which they live and develop. Once this is done, and there is no reason to doubt that it will be, the investigation of pathological protozoa and related microorganisms will probably become part of bacteriology. Hopefully, this investigation will explain the etiology of these as yet mysterious infectious diseases.

Until now I have intentionally left one question unexamined although it is precisely the one most often asked of bacteriologists, and, indeed, not without some reproach. I mean the question, "What has been achieved by all the arduous labor that has been invested in the examination of bacteria?" Actually one should not ask questions of this kind, for true research follows its own course, undaunted by considerations of utility. However, in this case the question is not totally unjustified. Very few bacteriologists have completely closed their eyes to practical goals.

The existing practical results of bacteriological investigation are by no means as insignificant as such questioners assume.

Consider only that which has been achieved in the area of disinfections. Precisely here there was, formerly, not a single clue; one moved in complete darkness. Even disregarding the indirect harm resulting from following defective rules of hygiene, great sums were often thrown away for useless disinfectants. In contrast, we now have reliable criteria with which to test the effectiveness of disinfectants. While much remains to be done, we can claim that the disinfectants currently in use really do fulfill their purposes.

Among practical results, one must also include the use of bacteriological methods to test water filtration; these methods cannot be replaced by any others. There are also the results of bacteriological investigations of the filtration properties of the soil and the important consequences for evaluating ground water as a water supply for the proper construction of springs. Similar techniques can be used to test milk and other foodstuffs as well as other articles that are suspected of spreading infection. The investigation of the air near watering canals and the consequential correction of widely held opinions that canal air is harmful, the investigation of air in class rooms, the identification of pathogenic bacteria in foodstuffs or soil all have practical consequences. Among the practical results of bacteriology I would also include the diagnosis of Asiatic cholera and of the first stages of tuberculosis. The first is important for prophylaxis and the second for treatment.

However, these results are only indirectly useful in the struggle against bacteria. We must not ignore therapeutic substances which are directly useful. One must mention the successes of Pasteur and others with immunizations against rabies, anthrax, *Rauschbrand*[5] and swine erysipelas. Rabies inoculation is the only one of these that is of use to humans. One could object that the cause of rabies is not yet known and is apparently not even a species of bacteria, and that this immunization, therefore, is not a result of bacteriology. However, this discovery has grown from the ground of bacteriology and would not have been possible without the preceding discoveries of protective inoculations against pathogenic bacteria.

In spite of endless effort, precisely in this area of bacteriological research one can display only meager results. Yet I do not believe that this will always remain so. On the contrary, I am convinced that bacteriology will yet be of great importance in therapy. Certainly, I anticipate less therapeutic success for diseases such as cholera that have a short incubation and a rapid course of development. For these diseases, the greatest emphasis will always be on prophylaxis. I have more hope for diseases that do not develop so rapidly; these are much more likely to provide a point of attack for therapeutic intervention. Partly for this reason, partly because it is so much more significant than any other infectious disease, tuberculosis is the greatest challenge to bacteriological investigation.

Shortly after discovery of the tubercule bacillus, such considerations led me to seek substances that would be therapeutically useful against tuberculosis. I have continued this quest, often interrupted by other professional matters, up to the present time. Others share the conviction that there must be substances for treating tuberculosis.

In a recent publication, Billroth expressed the same belief, and it is known that many other researchers seek the same goal.[6] Yet, in general they seem not to be following the proper course because they begin their experiments with humans. Thus, all the reputed discoveries, from sodium benzoate to hot-air treatments, have proved illusory. One should first experiment with isolated parasites in pure culture. Even then, when one finds substances that prevent the growth of tuberculosis bacilli in pure culture one should still not immediately experiment on humans. One must first conduct animal tests to determine whether observations made in the test tube also hold within living organisms. Only when such animal experiments have succeeded can one proceed to the use of humans.

Proceeding according to these rules, I have tested many substances to determine what influence they may have on pure cultures of tuberculosis bacilli. Even small doses of many substances hinder the growth of bacilli. Of course, it would be sufficient to retard development; it is not necessary, as is often assumed, actually to destroy the bacteria in the body. To make them harmless, it is sufficient to prevent their growth or reproduction.

Some of the most important substances that restrict the growth of tubercle bacilli are a number of ethereal oils. Among the aromatic compounds are 2-naphthylamine, paratoluidine, xylidine, some of the so-called animal dyes such as fuchsine, gentian violet, methyl blue, quinoline yellow, aniline yellow, auramine. Among the metals, mercury vapor, silver and gold compounds (in particular, cyangold compounds) exceeded all others in their effectiveness. Even diluted one to two parts per million these compounds retard the growth of tuberculosis bacilli. Yet all of these substances remain entirely without effect when employed within tuberculous animals.

In spite of these failures, I continued to quest and I ultimately found substances that halted the growth of tuberculosis bacilli not only in test tubes but also in animal bodies. As everyone who experiments with tuberculosis finds, investigations of the disease are very slow; and mine are no exception. Thus, although I have been occupied with these attempts for nearly one year, my study of these substances is not yet complete. I can only communicate that guinea pigs, which are known to be particularly susceptible to tuberculosis, if subjected to the operation of such substances, no longer react when injected with tuberculosis bacilli, and that in guinea pigs in which tuberculosis has already reached an advanced stage, the disease can be completely halted without otherwise harming the body.

At this time I conclude only that it is possible to render harmless the pathogenic bacteria that are found in a living body and to do this without disadvantage to the body. Previously, this possibility had been questioned.

However, the further hopes associated with these attempts may be fulfilled—it may be possible, given a bacterial infectious disease, to master the microscopic yet previously uncontrollable invaders within the human body. If so, I do not doubt that it will soon be possible to achieve the same results for other diseases. A very promising range of tasks will then be created. These tasks would provide subject matter for an international competition of the worthiest kind. My only reason for departing from my previous custom by reporting investigations that are not yet complete is to provide added incentive for additional attempts in this area.

Allow me, therefore, to conclude this lecture with the wish that the strengths of all nations may be measured in this field of labor and in war against the smallest but the most dangerous enemies of the human race, and that in this struggle, for the good of all humanity, the success of each nation may repeatedly surpass that of the others.

Source

Essays of Robert Koch. Translated from the German by K. Codell Carter. Westport, CT: Greenwood Press, 1987.

PART III

The Progressive Era

No country has yet been ruined by expenses incurred in protecting the public health.

—H. P. WALCOTT, Chairman of the Massachusetts Board of Health, 1886

The registration of vital statistics is the firm basis on which the whole structure of sanitary science and practice must rest.

—CHARLES V. CHAPIN, *Municipal Sanitation in the United States*, 1901

CHAPTER 18

JACOB A. RIIS
(1849–1914)

Long ago . . . it was said that 'one half of the world does not know how the other half lives.' . . . It did not know because it did not care . . . until some flagrant outrage on decency and the health of the community aroused it to noisy but ephemeral indignation.

—JACOB A. RIIS, *How the Other Half Lives*, 1890

JACOB A. RIIS WAS BORN IN RIBE, DENMARK, on May 3, 1849, the third of 13 children born to Niels and Carolina Riis. Jacob's father, a stern parent and schoolteacher at a Latin school, spent time editing a newspaper (whether it was a local paper or a school newspaper varies by account), and Jacob is said to have helped him with this work. At age 16 Jacob fell in love with Elizabeth Gortz, but her wealthy family rejected him as a suitor as he was "too common." At that point Jacob left Ribe for Copenhagen, where he apprenticed as a carpenter.

In 1870, at age 21, Riis came to the United States by steamer, seeking work as a carpenter. In this tumultuous time after the Civil War, more than 20 million persons were rapidly converging into U.S. urban areas, and Riis found himself just another faceless immigrant. He spent months walking the city streets, searching for work, more than once forced to seek shelter in police-run poor houses. The conditions in the shelters were so horrible that Riis vowed to have them shut down. He worked at several small jobs before landing a position as a police reporter with the *New York Evening Sun* in 1873. One year later he joined the *Brooklyn News* and wrote to Elizabeth to ask her to come to New York to marry him. This time she accepted.

In 1877, Riis took a position as police reporter for the *New York Tribune*, spending a great deal of his time in the city's crime-ridden and impoverished slums. He decided to make a difference for the downtrodden living in these places by documenting the conditions he experienced on his police beat, especially on the notorious Mulberry Street. The heart of Mulberry Street was "The Bend," the core of the New York slums. It was not easy getting pictures in this area, and Riis had to find ways to use flash powder for light. *Scribner's Magazine* began publishing Riis's photographs along with his essay on city life in 1877.

This work was later expanded to *How the Other Half Lives*, a work that convinced Commissioner of Police Theodore Roosevelt to close the police-run poor houses that Riis had previously vowed to close. For the next quarter century, Riis used a photographic medium to document the plight of the urban poor. He wrote 12 more books, including his autobiography *The Making of an American* in 1901. His photojournalistic efforts documented waves of immigration into the Lower East Side of Manhattan—German, Jewish, and Italian—showing how 100,000 persons were forced into tenement flats unfit for human habitation. The *Tribune* ran daily stories about tenement dwellers, setting a stage for public health, housing, and labor reform.

Critics of Riis note he used "muckraking journalism" to make his points. Some claim he had racial and ethnic prejudices because he proclaimed some of the poor as "worthy" (Germans and Poles), whereas he treated others with contempt (Italians). Other sources state he was biased against women. After the death of his first wife, Riis remarried in 1907. With his new wife Mary Phillips, Riis moved to a farm in Barre, Massachusetts. Riis's children all came from this second marriage. Riis died on May 26, 1914, at his Massachusetts farm.

A Note on the Text

Chapter 6 of *How the Other Half Lives* describes The Bend, the heart of Mulberry Street in 1877, a time when Riis spent his time poking about New York's alleys and tenements as a police reporter. The Bend began its history as a cow path, but by 1877, it was the core of the slums of the East Side. Riis was appalled by the wretchedness of the inhabitants of The Bend, by their "filth and foulness," and their depravity. He was clear that the tenements bred alcoholics, beggars, and criminals of all kinds—pimps and prostitutes, thieves, and rascals.

Riis agitated among the sanitary police for reforms in tenement housing, especially in The Bend, but had little success. Being cognizant of the power of photography on the battlefield during the Civil War, Riis hired a photographer to accompany him on his rounds at night so he would have images to make arguments to those in power. The status of photography, however, was not up to the challenge of the low levels of light in the tenements. Thus, Riis bought his own camera and taught himself to take photographs, creating new ways to take pictures in low-light situations. His determination finally brought about success when the new Tenement House Commission was established in 1884.

Riis's moral indignation, straight talk, and photojournalism became a lightning bolt for social reform in New York City. The young police commissioner, Theodore Roosevelt, not only closed the police lodging houses; he also closed the rear tenements and opened public playgrounds. It is reported that Roosevelt was so taken by Riis that he encouraged him to run for office, but Riis refused.

Riis's photojournalism opened a new era for newspapers, one we can still see in effect on newsstands today. His success stands in the form of Mulberry Street Park and the Jacob A. Riis Neighborhood House, which were built on the former site of The Bend.

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How the Other Half Lives
(1890, Abridged)

CHAPTER 6
The Bend

Where Mulberry Street crooks like an elbow within hail of the old depravity of the Five Points, is "the Bend," foul core of New York's slums. Long years ago the cows coming home from the pasture trod a path over this hill. Echoes of tinkling bells linger there still, but they do not call up memories of green meadows and summer fields; they proclaim the home-coming of the rag-picker's cart. In the memory of man the old cow-path has never been other than a vast human pig-sty. There is but one "Bend" in the world, and it is enough. The city authorities, moved by the angry protests of ten years of sanitary reform effort, have decided that it is too much and must come down. Another Paradise Park will take its place and let in sunlight and air to work such transformation as at the Five Points, around the corner of the next block. Never was change more urgently needed. Around "the Bend" cluster the bulk of the tenements that are stamped as altogether bad, even by the optimists of the Health Department. Incessant raids cannot keep down the crowds that make them their home. In the scores of back alleys, of stable lanes and hidden byways, of which the rent collector alone can keep track, they share such shelter as the ramshackle structures afford with every kind of abomination rifled from the dumps and ash barrels of the city. Here, too, shunning the light, skulks the unclean beast of dishonest idleness. "The Bend" is the home of the tramp as well as the rag-picker.

It is not much more than twenty years since a census of "the Bend" district returned only twenty-four of the six hundred and nine tenements as in decent condition. Three-fourths of the population of the "Bloody Sixth" Ward were then Irish. The army of tramps that grew up after the disbandment of the armies in the field, and has kept up its muster-roll, together with the in-rush of the Italian tide, have ever since opposed a stubborn barrier to all efforts at permanent improvement. The more that has been done, the less it has seemed to accomplish in the way of real relief, until it has at last become clear that nothing short of entire demolition will ever prove of radical benefit. Corruption could not have chosen ground for its stand with better promise of success. The whole district is a maze of narrow, often unsuspected passage-ways—necessarily, for there is scarce a lot that has not two, three, or four tenements upon it, swarming with unwholesome crowds. What a bird's-eye view of "the Bend" would be like is a matter of bewildering conjecture. Its everyday appearance, as seen from the corner of Bayard Street on a sunny day, is one of the sights of New York.

Bayard Street is the high road to Jewtown across the Bowery, picketed from end to end with the outposts of Israel. Hebrew faces, Hebrew signs, and incessant chatter in the queer lingo that passes for Hebrew on the East Side attend the curious wanderer to the very corner of Mulberry Street. But the moment he turns the corner the scene changes abruptly. Before him lies spread out what might better be the market-place in some town in Southern Italy than a street in New York—all but the houses; they are still the same old tenements of the unromantic type. But for once they do not make the fore-ground in a slum picture from the American metropolis. The interest centres not in them, but in the crowd they shelter only when the street is not preferable, and that with the Italian is only when it rains or he is sick. When the sun shines the entire population seeks the street, carrying on its household work, its bargaining, its love-making on street or side-walk, or idling there when it has nothing better to do, with the reverse of the impulse that makes the Polish Jew coop himself up in his den with the thermometer at stewing heat. Along the curb women sit in rows, young and old alike with the odd head-covering, pad or turban, that is their badge of servitude—hers to bear the burden as long as she lives—haggling over baskets of frowsy weeds, some sort of salad probably, stale tomatoes, and oranges not above suspicion. Ash-barrels serve them as counters, and not infrequently does not arrival of the official cart en route for the dump cause a temporary suspension of trade until the barrels have been emptied and restored. Hucksters and pedlars' carts make two rows of booths in the street itself, and along the houses is still another—a perpetual market doing a very lively trade in its own queer staples, found nowhere on American ground save in "the Bend." Two old hags, camping on the pavement, are dispensing stale bread, baked not in loaves, but in the shape of big wreaths like exaggerated crullers, out of bags of dirty bedtick. There is no use disguising the fact: they look like and they probably are old mattresses mustered into service under the pressure of a rush of trade. Stale bread was the one article the health officers, after a raid on the market, once reported as "not unwholesome." It was only disgusting. Here is a brawny butcher, sleeves rolled up above the elbows and clay pipe in mouth, skinning a kid that hangs from his hook. They will tell you with a laugh at the Elizabeth Street police station that only a few days ago when a dead goat had been reported lying in Pell Street it was mysteriously missing by the time the offal-cart came to take it away. It turned out that an Italian had carried it off in his sack to a wake or feast of some sort in one of the back alleys.

On either side of the narrow entrance to Bandits' Roost, one of the most notorious of these, is a shop that is a fair sample of the sort of invention necessity is the mother of in "the Bend." It is not enough that trucks and ash-barrels have provided four distinct lines of shops that are not down on the insurance maps, to accommodate the crowds. Here have the very hallways been made into shops. Three feet wide by four feet deep, they have just room for one, the shop-keeper, who, himself within, does his business outside, his wares displayed on a board hung across what was once the hall door. Back of the rear wall of this unique shop a hole has been punched from the hall into the alley and the tenants go that way. One of the shops is a "tobacco bureau," presided over by an unknown saint, done in yellow and red—there is not a shop, a stand, or an ash-barrel doing duty for a counter, that has not its patron saint—the other is a fish-stand full of slimy, odd-looking creatures, fish that never swam in American waters, or if they did, were never seen on an American fish-stand, and snails. Big, awkward sausages, anything but appetizing, hang in the grocer's doorway, knocking against the customer's head as if to remind him that they are there waiting to be bought. What they are I never had the courage to ask. Down the street comes a file of women carrying enormous bundles of fire-wood on their heads, loads of decaying vegetables from the market wagons in their aprons, and each a baby at the breast supported by a sort of sling that prevents it from tumbling down. The women do all the carrying, all the work one sees going on in "the Bend." The men sit or stand in the streets, on trucks, or in the open doors of the saloons smoking black clay pipes, talking and gesticulating as if forever on the point of coming to blows. Near a particularly boisterous group, a really pretty girl with a string of amber beads twisted artlessly in the knot of her raven hair has been bargaining long and earnestly with an old granny, who presides over a wheel-barrow load of second-hand stockings and faded cotton year, industriously darning the biggest holes while she extols the virtues of her stock. One of the rude swains, with patched overalls tucked into his boots, to whom the girl's eyes have strayed more than once, steps up and gallantly offers to pick her out the handsomest pair, whereat she laughs and pushes him away with a gesture which he interprets as an invitation to stay; and he does, evidently to the satisfaction of the beldame, who forthwith raises her prices fifty per cent. without being detected by the girl.

Red bandannas and yellow kerchiefs are everywhere; so is the Italian tongue, infinitely sweeter than the harsh gutturals of the Russian Jew around the corner. So are the "ristorantes" of innumerable Pasquales; half of the people in "the Bend" are christened Pasquale, or get the name in some other way. When the police do not know the name of an escaped murderer, they guess at Pasquale and send the name out on alarm; in nine cases out of ten it fits. So are the "banks" that hang out their shingle as tempting bait on every hand. There are half a dozen in the single block, steamship agencies, employment offices, and savings-banks, all in one. So are the toddling youngsters, bow-legged half of them, and so are no end of mothers, present and prospective, some of them scarce yet in their teens. Those who are not in the street are hanging half way out of the windows, shouting at some one below. All "the Bend" must be, if not altogether, at least half out of doors when the sun shines.

In the street, where the city wields the broom, there is at least an effort at cleaning up. There has to be, or it would be swamped in filth overrunning from the courts and alleys where the rag-pickers live. It requires more than ordinary courage to explore these on a hot day. The undertaker has to do it then, the police always. Right here, in this tenement on the east side of the street, they found little Antonia Candia, victim of fiendish cruelty, "covered," says the account found in the records of the Society for the Prevention of Cruelty to Children, "with sores, and her hair matted with dried blood." Abuse is the normal condition of "the Bend," murder its everyday crop, with the tenants not always the criminals. In this block, between Bayard, Park, Mulberry, and Baxter Streets, "the Bend" proper, the late Tenement House Commission counted 155 deaths of children[1] in a specimen year (1882). Their percentage of the total mortality in the block was 68.28, while for the whole city the proportion was only 46.20. The infant mortality in any city or place as compared with the whole number of deaths is justly considered a good barometer of its general sanitary condition. Here, in this tenement, No. 59½, next to Bandits' Roost, fourteen persons died that year, and eleven of them were children; in No. 61 eleven, and eight of them not yet five years old. According to the records in the Bureau of Vital Statistics only thirty-nine people lived in No. 59½ in the year 1888, nine of them little children. There were five baby funerals in that house the same year. Out of the alley itself, No. 59, nine dead were carried in 1888, five in baby coffins. Here is the record of the year for the whole block, as furnished by the Registrar of Vital Statistics, Dr. Roger S. Tracy.

The general death-rate for the whole city that year was 26.27.

These figures speak for themselves, when it is shown that in the model tenement across the way at Nos. 48 and 50, where the same class of people live in greater swarms (161, according to the record,), but under good management, and in decent quarters, the hearse called that year only twice, once for a baby. The agent of the Christian people who built that tenement will tell you that Italians are good tenants, while the owner of the alley will oppose every order to put his property in repair with the claim that they are a bad lot. Both are right, from their different standpoints. It is the stand-point that makes the difference—and the tenant.

What if I were to tell you that this alley, and more tenement property in "the Bend," all of it notorious for years as the vilest and worst to be found anywhere, stood associated on the tax-books all through the long struggle to make its owners responsible, which has at last resulted in a

Deaths and Death-rates in 1888 in Baxter and Mulberry Streets, between Park and Bayard Streets

	Population			**Deaths**			**Death-rate**		
	Five years old and over	**Under five years**	**Total**	**Five years old and over**	**Under five years**	**Total**	**Five years old and over**	**Under five years**	**Total**
Baxter Street	1,918	315	2,233	26	46	72	13.56	146.02	32.24
Mulberry Street	2,788	629	3,417	44	86	130	15.78	136.70	38.05
Total	4,706	944	5,650	70	132	202	14.87	139.83	35.75

qualified victory for the law, with the name of an honored family, one of the "oldest and best," rich in possessions and in influence, and high in the councils of the city's government? It would be but the plain truth. Nor would it be the only instance by very many that stand recorded on the Health Department's books of a kind that has come near to making the name of landlord as odious in New York as it has become in Ireland.

Bottle Alley is around the corner in Baxter Street; but it is a fair specimen of its kind, wherever found. Look into any of these houses, everywhere the same piles of rags, of malodorous bones and musty paper, all of which the sanitary policy flatter themselves they have banished to the dumps and the warehouses. Here is a "flat" or "parlor": and two pitch-dark coops called bedrooms. Truly, the bed is all there is room for. The family tea-kettle is on the stove, doing duty for the time being as a wash-boiler. By night it will have returned to its proper use again, a practical illustration of how poverty in "the Bend" makes both ends meet. One, two, three beds are there, if the old boxes and heaps of foul straw can be called by that name; a broken stove with crazy pipe from which the smoke leaks at every joint, a table of rough boards propped up on boxes, piles of rubbish in the corner. The closeness and smell are appalling. How many people sleep here? The woman with the red bandanna shakes her head sullenly but the bare-legged girl with the bright face counts on her fingers—five, six!

"Six, sir!" Six grown people and five children.

"Only five," she says with a smile, swathing the little one on her lap in its cruel bandage. There is another in the cradle—actually a cradle. And how much the rent?

Nine and a half, and "please, sir! He won't put the paper on."

"He" is the landlord. The "paper" hangs in musty shreds on the wall.

Well do I recollect the visit of a health inspector to one of these tenements on a July day when the thermometer outside was climbing high in the nineties; but inside, in that awful room, with half a dozen persons washing, cooking, and sorting rags, lay the dying baby alongside the stove, where the doctor's thermometer ran up to 115°! Perishing for the want of a breath of fresh air in this city of untold charities! Did not the manager of the Fresh Air Fund write to the pastor of an Italian Church only last year[2] that "no one asked for Italian children," and hence he could not send any to the country?

Half a dozen blocks up Mulberry Street there is a rag-picker's settlement, a sort of overflow from "the Bend," that exists to-day in all its pristine nastiness. Something like forty families are packed into five old two-story and attic houses that were built to hold five, and out of the yards additional crowds are, or were until very recently, accommodated in sheds built of all sorts of old boards and used as drying racks for the Italian tenants' "stock." I found them empty when I visited the settlement while writing this. The last two tenants had just left. Their fate was characteristic. The "old man," who lived in the corner coop, with barely room to crouch beside the stove—there would not have been room for him to sleep had not age crooked his frame to fit his house—had been taken to the "crazy house," and the woman who was his neighbor and had lived in her shed for years had simply disappeared. The agent and the other tenants "guessed," doubtless correctly, that she might be found on the "island," but she was decrepit anyhow from rheumatism, and "not much good," and no one took the trouble to inquire for her. They had all they could do attending to their own business and raising the rent. No wonder; I found that for one front room and two "bed-rooms" in the shameful old wrecks of buildings the tenant was paying $10 a month, for the back-room and one bed-room $9, and for the attic rooms, according to size, from $3.75 to $5.50.

There is a standing quarrel between the professional—I mean now the official—sanitarian and the unsalaried agitator for sanitary reform over the question of overcrowded tenements. The one puts the number a little vaguely at four or five hundred, while the other asserts that there are thirty-two thousand, the whole number of houses classed as tenements at the census of two years ago, taking no account of the better kind of flats. It depends on the angle from which one sees it which is right. At best the term overcrowding is a relative one, and the scale of official measurement conveniently sliding. Under the pressure of the Italian influx the standard of breathing space required for an adult by the health officers has been cut down from six to four hundred cubic feet. The "needs of the situation" is their plea, and no more perfect argument could be advanced for the reformer's position.

It is in "the Bend" the sanitary policeman locates the bulk of his four hundred, and the sanitary reformer gives up the task in despair. Of its vast homeless crowds the census takes no account. It is their instinct to shun the light, and they cannot be corralled in one place long enough to be counted. But the houses can, and the last count showed that in "the Bend" district between Broadway and the Bowery and Canal and Chatham Streets, in a total of four thousand three hundred and sixty-seven "apartments" only nine were for the moment vacant, while in the old "Africa," Street west of Broadway, that receives the overflow from Mulberry Street and is rapidly changing its character, the notice "standing room only" is up. Not a single vacant room was found there. Nearly a hundred and fifty "lodgers" were driven out of two adjoining Mulberry Street tenements, one of them aptly named "the House of Blazes," during that census. What squalor and degradation inhabit these dens the health officers know. Through the long summer days their carts patrol "the Bend," scattering disinfectants in streets and lanes, in sinks and cellars, and hidden hovels where the tramp burrows. From midnight till far into the small hours of the morning the policeman's thundering rap on closed doors is heard, with his stern command, "*Apri port'!*" on his rounds gathering evidence of illegal overcrowding. The doors are opened unwillingly enough—but the order means business, and the tenant knows it even if he understands no word of English—upon such scenes as the one presented in the picture. It was photographed by flash-light on just such a visit [Photo not provided. Ed.]. In a room not thirteen feet either way slept twelve men and women, two or three in bunks set in a sort of alcove, the rest on the floor. A kerosene lamp burned dimly in the fearful atmosphere, probably to guide other and later arrivals to their "beds," for it was only just past midnight. A baby's fretful wail came from an adjoining hall-room, where, in the semi-darkness, three recumbent figures could be made out. The "apartment" was one of three in two adjoining buildings we had found, within half an hour, similarly crowded. Most of the men were lodgers, who slept there for five cents a spot.

Another room on the top floor, that had been examined a few nights before, was comparatively empty. There were only four persons in it, two men, an old woman, and a young girl. The landlord opened the door with alacrity, and exhibited with a proud sweep of his hand the sacrifice he had made of his personal interests to satisfy the law. Our visit had been anticipated. The policemen's back was probably no sooner turned than the room was reopened for business.

Source

Riis, Jacob A. *How the Other Half Lives*. 1890. New York: Charles Scribner's Sons, 1901. An unabridged replication of the 1901 edition was published in New York by Dover Publications in 1971. Also available online at www.cis.yale.edu/amstud/inforev/riis/title.html.

CHAPTER 19

UPTON SINCLAIR
(1878–1968)

It is difficult to get a man to understand something when his job depends on not understanding it.

—Upton Sinclair, comment, c. 1906

Upton Beall Sinclair Jr. was born to Upton Sr. and Priscilla Harden Sinclair on September 20, 1878, in Baltimore, Maryland. A poor family with Confederate sympathies, the Sinclairs moved to New York City in 1888, where Upton Jr. alternated between living with his destitute family and his wealthy grandparents. He later attributed his socialist leanings to the contrasts he observed in living in these two extremes.

Sinclair was a religious child who claimed his two heroes were Jesus and Percy Bysshe Shelley. At 14, he was admitted to New York City College. Although tuition was free, Sinclair needed funds for transportation, food, and other expenses, so he began to write dime novels and fictional magazine stories. By the time he was 17, he was able to cover his graduate study costs at Columbia University and send money to his parents.

In 1900, Sinclair married Meta H. Fuller. A year later, he published his first novel, *Springtime and Harvest*. Four other novels soon followed, but none were well received either by critics or the buying public. Sinclair's socialist leanings were engaged by many of the writers of the period, especially muckraking journalists such as Ida Tarbell. Of particular influence on Sinclair was Frank Norris, a novelist whose works (such as *The Octopus*) described the impact of major societal forces (such as railroad monopolies) on the common man. It was an approach Sinclair adopted.

The socialist magazine *Appeal to Reason* asked Sinclair in 1904 to write a novel about immigrants laboring in the Chicago meatpacking industry. With less than two months of research into the subject, Sinclair penned his classic *The Jungle. Appeal to Reason* serialized the novel, and the magazine's circulation sharply increased. Despite the clear public interest in Sinclair's serialized novel, six publishers rejected its full publication, aghast at the work's advocacy of socialism. Sinclair decided to self-publish *The Jungle* and placed an advertisement for the prepublished work in *Appeal to Reason*. Orders for 972 books followed, and Sinclair contacted Doubleday with this information. Doubleday decided to publish the book, and in a short time period, 150,000 copies were sold. The book was an instant success, achieving worldwide sales after being translated into 17 languages.

Among the readers of *The Jungle* was President Theodore Roosevelt. The young president was not sympathetic to the novel's socialist bent, and he told Sinclair as much when the two eventually met. But Roosevelt was also not sympathetic to the ethos of the "maximum profit no matter the cost" approach the meatpacking industry magnates practiced. In less than a year after *The Jungle*'s publication, Roosevelt would sign into law the Pure Food and Drug Act of 1906 and the Meat Inspection Act (1906). Yet Sinclair felt frustrated with this response. He hadn't intended to arouse the public simply to reform an industry; he sought to stimulate solutions to the challenges faced by immigrants in an industrialized capitalist society.

Though a socialist, Sinclair was not a communist. Five years into the new century found Sinclair joining with Jack London and Clarence Darrow, among others, to form the Intercollegiate Socialist Society. The next year, Sinclair tried building on his fame as the author of *The Jungle* and ran for election to Congress from New Jersey on the Socialist Party ticket. The exercise was a major failure, as he garnered less than 1,000 votes of the 24,000 cast. Later that year, with the proceeds from *The Jungle*, Sinclair founded the Helicon Home Colony in Englewood, New Jersey. This socialist commune anticipated the establishment of similar groups in the United States six decades later. (Among the early members was Sinclair Lewis, who would later vilify Upton Sinclair as an opportunistic fascist in *It Couldn't Happen Here*.) The Helicon experiment came to an abrupt end when barely four months after it opened the entire commune was consumed in a fire. Arson was suspected but never proven. Sinclair divorced his first wife in 1911 during his travels in Europe. He subsequently married Mary Craig Kimbrough.

Sinclair's next six novels were commercial and critical flops. In 1914, he moved to Croton-on-Hudson, where he lived among many of the leading socialists of the era. The onset of World War I challenged Sinclair, and he bolted from the party when reports of atrocities by the Germans became known. The commercial acceptance of his work was not much changed by this action, and he subsequently rejoined the party. After moving to Pasadena, California, Sinclair stood as its 1920 candidate for Congress, 1922 nominee for the Senate, and 1926 candidate for governor of California. Those campaigns, like his first one running for Congress, were all major failures.

With the coming of the Great Depression, Sinclair found his political voice.

He sought the governorship of California as the Democratic nominee in 1934, campaigning on a platform of End Poverty in California (EPIC), a program foreshadowing Social Security. When he was informed of President Franklin D. Roosevelt's decision to push for the Social Security Program, Sinclair agreed to delay his own program until Roosevelt's proposal was made public (though that would be after the election). Sinclair's campaign subsequently slowed, and he lost the race with almost 900,000 votes to the slightly more than 1.1 million cast for the winner. Sinclair's campaign marked the high point for socialism in the United States.

In 1940, with the rise of fascism in Europe, Sinclair began a series of 11 novels on American government. The series was both a commercial and critical success. One book in the series, *Dragon's Teeth*, concerned the rise of the Nazis in Europe; it was awarded the Pulitzer Prize in 1942. The year 1953 had Sinclair on the move again, settling in Buckeye, Arizona. Though he would continue to write, including two volumes on his life, Sinclair's best efforts were now behind him. Following the death of his wife (Mary Craig Kimbrough) in 1961, he married Mary Elizabeth Willis; they remained married until her death six years later.

After a prolific career including more than 90 novels, Sinclair died on November 25, 1968, at the Somerset Valley Nursing Home in Bound Brook, New Jersey.

A Note on the Text

The Jungle is arguably Upton Sinclair's most famous work. It illustrates the struggles of Eastern European immigrants contending with the factories that had emerged during the Industrial Revolution in the United States during the previous half a century. Sinclair had not intended for his novel to result in legislative reform of the meatpacking industry, though this was indeed its principal effect. "I aimed at the public's heart, and by accident I hit it in the stomach," he famously complained.

The reading public of the time were not much interested in arguments about the merits of socialism. For example, President Theodore Roosevelt was repelled by both the vivid descriptions of the manner in which meat was processed at a typical meatpacking plant and the heavy-handed criticisms of American capitalist society spewed out by Sinclair. The manner in which Sinclair characterized minorities in the novel was not charitable, either. Some suggested these images reflected Sinclair's own racist views, while others were less sanguine. The Eastern European immigrants are shown as confused about their new environs and powerless to contend with the societal forces that shape their lives. They are effectively trapped in a system whose workings they simply do not understand.

The effect of *The Jungle* was to move the public to call for legislative reform.

The result was the Pure Food and Drug Act of 1906, also known as the Wiley Act, which was charged the Department of Agriculture with protecting the public from tainted pharmaceuticals as well as food goods. Thus, Sinclair brought about reforms that preserved the very system he inveighed against. He failed to rouse the American public to action against capitalism.

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The Jungle
(1905, Abridged)

CHAPTER 3 (Excerpted)

There were two hundred and fifty miles of track within the yards, their guide went on to tell them. They brought about ten thousand head of cattle every day, and as many hogs, and half as many sheep—which meant some eight or ten million live creatures turned into food every year. One stood and watched, and little by little caught the drift of the tide, as it set in the direction of the packing houses. There were groups of cattle being driven to the chutes, which were roadways about fifteen feet wide, raised high above the pens. In these chutes the stream of animals was continuous; it was quite uncanny to watch them, pressing on to their fate, all unsuspicious—a very river of death. . . .

. . . Then the party went across the street to where they did the killing of beef—where every hour they turned four or five hundred cattle into meat. Unlike the place they had left, all this work was done on one floor, and instead of there being one line of carcasses which moved to the workmen, there were fifteen or twenty lines, and the men moved from one to another of these. This made a scene of intense activity, a picture of human power wonderful to watch. It was all in one great room like a circus amphitheater, with a gallery for visitors running over the center.

Along one side of the room ran a narrow gallery, a few feet from the floor, into which gallery the cattle were driven by men with goads which gave them electric shocks. Once crowded in here, the creatures were prisoned, each in a separate pen, by gates that shut, leaving them no room to turn around, and while they stood bellowing and plunging, over the top of the pen there leaned one of the "knockers," armed with a sledge hammer, and watching for a chance to deal a blow. The room echoed with the thuds in quick succession, and the stamping and kicking of the steers. The instant the animal had fallen, the "knocker" passed on to another, while a second man raised a lever, and the side of the pen was raised, and the animal, still kicking and struggling, slid out to the "killing bed." Here a man put shackles about one leg, and pressed another lever, and the body was jerked up into the air. There were fifteen or twenty such pens, and it was a matter of only a couple of minutes to knock fifteen or twenty cattle and roll them out. Then once more the gates were opened, and another lot rushed in; and so out of each pen there rolled a steady stream of carcasses, which the men upon the killing beds had to get out of the way.

The manner in which they did this was something to be seen and never forgotten. They worked with furious intensity, literally upon the run—at a pace with which there is nothing to be compared except a football game. It was all highly specialized labor, each man having his task to do; generally this would consist of only two or three specific cuts, and he would pass down the line of fifteen or twenty carcasses, making these cuts upon each. First there came the "butcher" to bleed them; this meant one swift stroke, so swift that you could not see it—only the flash of the knife; and before you could realize it, the man had darted out upon the floor. This floor was half an inch deep with blood, in spite of the best efforts of men who kept shoveling it though holes; it must have made the floor slippery, but no one could have guessed this by watching the men at work.

The carcass hung for a few minutes to bleed; there was no time lost, however, for there were several hanging in each line, and one was always ready. It was let down to the ground, and there came the "headman," whose task it was to sever the head, with two or three swift strokes. Then came the "floorsman," to make the first cut in the skin; and then another to finish ripping the skin down the center; and then half a dozen more in swift succession, to finish the skinning. After they were through, the carcass was again swung up, and while a man with a stick examined the skin, to make sure that it had not been cut, and another rolled up and tumbled it through one of the inevitable holes in the floor, the beef proceeded on its journey. There were men to cut it, and men to split it, and men to gut it and scrape it clean inside. There were some with hoses which threw jets of boiling water upon it, and others who removed the feet and added the final touches. In the end, as with the hogs, the finished beef was run into the chilling room, to hang its appointed time.

The visitors were taken there and shown them, all neatly hung in rows, labeled conspicuously with the tags of the government inspectors—and some, which had been killed by a special process, marked with the sign of the "kosher" rabbi, certifying that it was fit for sale to the orthodox. And then the visitors were taken to the other parts of the building, to see what became of each particle of the waste material that had vanished through the floor; and to the pickling rooms, and the salting rooms, the canning rooms, and the packing rooms, where choice meat was prepared for shipping in refrigerator cars, destined to be eaten in all the four corners of civilization. . . .

CHAPTER 9 (Excerpted)

The people of Chicago saw the government inspectors in Packingtown, and they all took that to mean that they were protected from diseased meat; they did not understand that these hundred and sixty-three inspectors had been appointed at the request of the packers, and that they were paid by the United States government to certify that all the diseased meat was kept in the state. They had no authority beyond that; for the inspection of meat to be sold in the city and state the whole force in Packingtown consisted of these henchmen of the local political machine![1] And shortly afterward one of these, a physician, made the discovery that the carcasses of steers which had been condemned as tubercular by the government inspectors, and which therefore contained ptomaines, which are deadly poisons, were left upon an open platform and carted away to be sold in the city; and so he insisted that these carcasses be treated with an injection of kerosene—and was ordered to resign the same week! So indignant were the packers that they went farther, and compelled the mayor to abolish the whole bureau of inspection; so that since then there has not been even a pretence of any interferences with the graft. There was said to be two thousand dollars a week hush money from the tubercular steers alone, and as much again from the hogs which had died of cholera on the trains, and which you might see any day being loaded into box cars and hauled away to a place called Globe, in Indiana, where they made a fancy grade of lard. . . .

. . . There was another interesting set of statistics that a person might have gathered in Packingtown—those of the various afflictions of the workers. When Jurgis had first inspected the packing plants with Szedvilas, he had marveled while he listened to the tale of all the things that were made out of the carcasses of animals, and of all the lesser industries that were maintained there; now he found that each one of these lesser industries was a separate little inferno, in its way as horrible as the killing-beds, the source and fountain of them all. The workers in each of them had their own peculiar diseases. And the wandering visitor might be sceptical [*sic*] about all the swindles, but he could not be sceptical about these, for the worker bore the evidence of them about on his own person—generally he had only to hold out his hand.

There were men in the pickle room, for instance, where old Antanas had gotten his death; scarce a one of these that had not some spot of horror on his person. Let a man so much as scrape a finger pushing a truck in the pickle rooms, and he might have a sore that would put him out of the world; all the joints in his fingers might be eaten by the acid, one by one. Of the butchers and floorsmen, the beef boners and trimmers, and all those who used knives, you could scarcely find a person who had the use of his thumb; time and time again the base of it had been slashed, till it was a mere lump of flesh against which the man pressed the knife to hold it. The hands of these men would be criss-crossed with cuts, until you could no longer pretend to count them or to trace them. They would have not nails,—they had worn them off pulling hides; their knuckles were swollen so that their fingers spread out like a fan. There were men who worked in the cooking rooms, in the midst of steam and sickening odors, by artificial light; in these rooms the germs of tuberculosis might live for two years, but the supply was renewed every hour. . . . [A]nd as for the other men, who worked in tank rooms full of steam, and in some of which there were open vats near the level of the floor, their peculiar trouble was that they fell into the vats; and when they were fished out, there was never enough of them left to be worth exhibiting—sometimes they would be overlooked for days, till all but the bones of them had gone out to the world as Durham's Pure Leaf Lard!

Source

Sinclair, Upton. *The Jungle*. 1906. Reprinted, New York: Signet Classic, 1990.

CHAPTER 20

ABRAHAM FLEXNER
(1866–1959)

Nations have recently been led to borrow billions for war; no nation has ever borrowed largely for education . . . no nation is rich enough to pay for both war and civilization. We must make our choice; we cannot have both.

—Abraham Flexner, *Universities*, 1930

Abraham flexner was born on november 13, 1866, in Louisville, Kentucky, to Esther and Morris Flexner, educated Jewish immigrants from Eastern Europe. Flexner's father was a successful wholesale merchant. Unlike his older brother Simon (for whom Flexner's dysentery is named), Flexner had no interest in medicine; his life focus from an early age was education.

A product of the Louisville public school system, Flexner attended Johns Hopkins University as an undergraduate, completing his studies at 19 years. He immediately returned to Louisville High School and began his teaching career. Flexner quickly concluded that the instructional model used in public schools—didactic lectures—was not optimal for student learning. Accordingly, in 1890, he founded a college preparatory school in Louisville dedicated to his alternative, less structured approach; he directed it for the next 15 years. The school produced a number of top-level students and soon attracted national attention. In 1898, he married Anne Laziere Crawford.

By 1905, Flexner felt ready for graduate studies, and he enrolled in the graduate education program at Harvard University. The next year, he received his M.A. degree. During 1907–1908, Flexner studied at the University of Berlin. At the conclusion of his studies, in 1908, Flexner published his analysis of American graduate education: *The American College: A Criticism*. His analysis was stinging in its criticism of the widespread use of lectures as the mainstay of undergraduate education in the United States. One of those noting Flexner's comments was Henry Pritchett, president of the Carnegie Foundation for the Advancement of Teaching. Pritchett was interested in sponsoring a series of studies of American graduate education. In the author of *The American College: A Criticism*, Pritchett thought he had the ideal candidate to undertake the project.

At the Carnegie Foundation, Flexner's first focus was medical education. His approach was an exhaustive review of all existent medical education programs in the United States. He noted the differences in student preparation required by each program and the degree to which the programs produced physicians equipped to handle the scientific advances then taking place within medicine. Flexner's report (from which our reading has been selected)—*Medical Education in the United States and Canada*—was scathing in its derision of those programs that provided little scientific base for the future physician to remain abreast of new developments. Flexner soon completed a complementary work on medical education in Europe, which soon become widely known.

In 1912, Flexner joined the General Education Board of the Rockefeller Foundation, serving first as its assistant secretary and, after 1917, as its secretary. In 1916, he published *A Modern School*, detailing his vision for education as an enabler of a literate, informed, democratic society and noting the need for improvements in the education system in the United States. His continued work on the board focused on bringing about improvements in medical education in the United States. At the same time, he began a reexamination of the American college, returning to an earlier focus of activity. The 1930 publication of *Universities: American, English, German* critiqued the expansion of activities in many universities to include sports and other "nonacademic" work thought by Flexner to be distractions.

In 1930, his work at the General Education Board complete, Flexner founded the Institute for Advanced Studies (IAS) in Princeton, New Jersey. The IAS would function as Flexner's ideal academic environment for the creation of new knowledge. During his tenure running the IAS, Flexner recruited a stellar faculty, including Albert Einstein and Kurt Gödel. By the time of Flexner's retirement in 1939, the IAS was established as one of the premier research institutions in the United States, though it had no students and gave no degrees.

For the remaining two decades of his life, Flexner lived in semiretirement. He completed one final report in 1952 with a focus on foundations rather than education: *Funds and Foundations: Their Policies Past and Present*. However, its impact paled in comparison with Flexner's earlier offerings. Flexner died in Falls Church, Virginia, on September 21, 1959, and is interred at Cave Hill Cemetery in Louisville.

A Note on the Text

The selected reading comes from Flexner's 1910 critique of medical education in the United States. At the time of its writing, barely a century ago, many medical schools in the United States were owned by physicians. Such schools often lacked elements now considered integral to medical education, including dissection and other laboratory work. Remarkably, of the 155 schools, barely 16 required anything more than a couple of years of college prior to admission into medical school. Flexner called for a clinical focus in the schools, and he clarified the importance of a full-time clinical faculty. Flexner drew heavily on the success of the model pioneered by Johns Hopkins University's medical school in making his recommendations. He also framed his remarks in the context of medical education in Europe (though that would be the focus of a separate report), in which one could not attend medical school without a complete undergraduate education.

The impact of the report was immediate and severe. Many medical schools closed their doors, never to be reopened. The curricula of those schools remaining in operation were strengthened, and students were given expectations to fulfill for graduation considerably beyond those previously existent. It is a tribute to the success of this report that in spite of Flexner's considerable productivity throughout his lifetime it is this particular piece for which he is most remembered.

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Medical Education in the United States & Canada: A Report to the Carnegie Foundation for the Advancement of Teaching
(1910, Abridged)

CHAPTER II
The Proper Basis of Medical Education

We have in the preceding chapter briefly indicated three stages in the development of medical education in America,—the preceptorship, the didactic school, the scientific discipline. We have seen how an empirical training of varying excellence, secured through attendance on a preceptor, gave way to the didactic method, which simply communicated a set body of doctrines of very uneven values; how in our day this didactic school has capitulated to a procedure that seeks, as far as may be, to escape empiricism in order to base the practice of medicine on observed facts of the same order and cogency as pass muster in other fields of pure and applied science. The apprentice saw disease; the didactic pupil heard and read about it; now once more the medical student returns to the patient, whom in the main he left when he parted with his preceptor. But he returns, relying no longer altogether on the senses with which nature endowed him, but with those senses made infinitely more acute, more accurate, and more helpful by the processes and the instruments which the last half-century's progress has placed at his disposal. This is the meaning of the altered aspect of medical training: the old preceptor, be he never so able, could at best feel, see, smell, listen, with his unaided senses. His achievements are not indeed to be lightly dismissed; for his sole reliance upon his senses greatly augmented their power. Succeed as he might, however, his possibilities in the way of reducing, differentiating, and interpreting phenomena, or significant aspects of phenomena, were abruptly limited by his natural powers. These powers are nowadays easily enough transcended. The self-registering thermometer, the stethoscope, the microscope, the correlation of observed symptoms with the outgivings of chemical analysis and biological experimentation, enormously extend the physician's range. He perceives more speedily and more accurately what he is actually dealing with; he knows with far greater assurance the merits or the limitations of the agents which he is in position to invoke. Though the field of knowledge and certainty is even yet far from coextensive with the field of disease and injury, it is, as far as it goes, open to quick, intelligent, and effective action.

Provided, of course, the physician is himself competent to use the instrumentalities that have been developed! There is just now the rub. Society reaps at this moment but a small fraction of the advantage which current knowledge has the power to confer. The sick man is relatively rare for whom actually all is done that is at this day humanly feasible,—as feasible in the small hamlet as in the large city, in the public hospital as in the private sanatorium. We have indeed in America medical practitioners not inferior to the best elsewhere; but there is probably no other country in the world where there is so great a distance and so fatal a difference between the best, the average, and the worst.

The attempt will be made in this chapter and the next to account for these discrepancies in so far as they are traceable to circumstances that antedate the formal beginning of medical education itself. The mastery of the resources of the profession in the modern sense is conditioned upon certain definite assumptions, touching the medical student's education and intelligence. Under the apprentice system, it was not necessary to establish any such general or uniform basis. The single student was in personal contact with his preceptor. If he were young or immature, the preceptor could wait upon his development, initiating him in simple matters as they arose, postponing more difficult ones to a more propitious season; meanwhile, there were always the horses to be curried and the saddle-bags to be replenished. In the end, if the boy proved incorrigibly dull, the preceptor might ignore him till a convenient excuse discontinued the relation. During the ascendancy of the didactic school, it was indeed essential to good results that lecturers and quizmasters should be able to gauge the general level of their huge classes; but this level might well be low, and in the common absence of conscientiousness usually fell far below the allowable minimum. In any event, the student's part was, parrotlike, to absorb. His medical education consisted largely in getting by heart a prearranged system of correspondences,—an array of symptoms so set off against a parallel array of doses that, if he noticed the one, he had only to write down the other: a coated tongue—a course of calomel; a shivery back—a round of quinine. What the student did not readily apprehend could be drilled into him—towards examination time—by those who had themselves recently passed through the ordeal which he was now approaching; and an efficient apparatus that spared his senses and his intellect as entirely as the drillmaster spared his industry was readily accessible at temptingly low prices in the shape of "essentials" and "quiz-compends." Thus he got, and in places still gets, his material medica, anatomy, obstetrics, and surgery. The medical schools accepted the situation with so little reluctance that these compends were—and essentially still are—written by professors and sold on the premises. Under such a regime anybody could, as President Eliot remarked, "walk into a medical school from the street," and small wonder that of those who did walk in, many "could barely read and write."[1] But with the advent of the laboratory, in which every student possesses a locker where his individual microscope, reagents, and other paraphernalia are stored for his personal use; with the advent of the small group bedside clinic, in which every student is responsible for a patient's history and for a brief diagnosis, suggested, confirmed, or modified by his own microscopial and chemical examination of blood, urine, sputum, and other tissues, the privileges of the medical school can no longer be open to casual strollers from the highway. It is necessary to install a doorkeeper who will, by critical scrutiny, ascertain the fitness of the applicant: a necessity suggested in the first place by consideration for the candidate, whose time and talents will serve him better in some other vocation, if he be unfit for this; and in the second, by consideration for a public entitled to protection from those whom the very boldness of modern medical strategy equips with instruments that, tremendously effective for good when rightly used, are all the more terrible for harm if ignorantly or incompetently employed.

A distinct issue is here presented. A medical school may, the law permitting, eschew clinics and laboratories, cling to the didactic type of instruction, and arrange its dates so as not to conflict with seedtime and harvest; or it may equip laboratories, develop a dispensary, and annex a hospital, pitching its entrance requirements on a basis in keeping with its opportunities and pretensions. But it cannot consistently open the latter type of school to the former type of student. It cannot provide laboratory and bedside instruction on the one hand, and admit crude, untrained boys on the other. The combination is at once illogical and futile. The funds of the school may indeed procure facilities; but the intelligence of the students can alone ensure their proper use. Nor can the dilemma be evaded by alleging that a small amount of laboratory instruction administered to an unprepared medical student makes a "practitioner," while the more thorough training of a competent man makes a "scientist." At the level of which under the most favorable circumstances the medical student gets his education, it is absurd to speak of an inherent conflict between science and practice. We shall have occasion later to touch on the relation of teaching and research, between which it is necessary to establish a *modus vivendi*. But that problem has nothing to do with the point now under discussion,—*viz.*, as to how much education or intelligence it requires to establish a reasonable presumption of fitness to undertake the study of medicine under present conditions.

Taking, then, modern medicine as an attempt to fight the battle against disease most advantageously to the patient, what shall we require of those who propose to enlist in the service? To get a somewhat surer perspective in dealing with a question around which huge clouds of dust have been beaten up, let us for a moment look elsewhere. A college education is not in these days a very severe or serious discipline. It is compounded in varying proportions of work and play; it scatters whatever effort it requires, so that at no point need the student stand the strain of prolonged intensive exertion. Further, the relation of college education to specific professional or vocational competency is still under dispute. It is clear, then, that a college education is less difficult, less trying, less responsible, than a four-year high school training, scholastically determined, whether by examination of the candidate or by appraisement of the school.

Technical schools of engineering and the mechanic arts afford perhaps an even more illuminating comparison. These institutions began, like the college, at a low level; but they did not long rest there. Their instruction was too heavily handicapped by ignorance and immaturity. To their graduates, tasks involving human life and welfare were committed: the building of bridges, the installation of power plants, the construction of sewage systems. The technical school was thus driven to seek students of greater maturity, of more thorough preliminary schooling, and strictly to confine its opportunities to them. Now it is noteworthy that, though in point of intensive strain the discipline of the modern engineer equals the discipline of the modern physician, in one important respect, at least, it is less complex and exacting. The engineer deals mainly with measurable factors. His factor of uncertainly is within fairly narrow limits. The reasoning of the medical student is much more complicated. He handles at one and the same time elements belonging to vastly different categories: physical, biological, psychological elements are involved in each other. Moreover, the recent graduate in engineering is not at once exposed to a decisive responsibility; to that he rises slowly through a lengthy series of subordinate positions that search out and complete his education.[2] Between the young graduate in medicine and his ultimate responsibility—human life—nothing interposes. He cannot nowadays begin with easy tasks under the surveillance of a superior; the issues of life and death are all in the day's work for him from the very first. The training of the doctor is therefore more complex and more directly momentous than that of the technician. Be it noted, then, that the minimum basis upon which a good school of engineering today accepts students is, once more, an actual high school education, and that the movement towards elongating the technical course to five years confesses the urgent need of something more.

There is another aspect of the problem equally significant. The curriculum of the up-to-date technical school is heavily weighted, to be sure; but except for mathematics, the essential subjects with which it starts are separate sciences that presuppose no prior mastery of contributory sciences. Take at random the College of Engineering at the University of Wisconsin. In the first year the science work is chemistry, and though the course is difficult, it demands no preceding acquaintance with chemistry itself or with any other science; second-year physics is in the same case, and the mechanics of the second semester looks back no further than to the physics of the first.

Very different is the plight of the medical school. There the earliest topics of the curriculum proper—anatomy, physiology, physiological chemistry—already hark back to a previous scientific discipline. Every one of them involves already acquired knowledge and manipulative skill. They are laboratory sciences at the second, not the primary, stage. Consider, for example, anatomy, the simplest and most fundamental of them all. It used to begin and end with the dissection of the adult cadaver. It can neither begin nor end there today; for it must provide the basis upon which experimental physiology, pathology, and bacteriology may intelligently be built up. Mere dissection does not accomplish this; in addition to gross anatomy, the student must make out under the microscope the normal cellular structure of organ, muscle, nerve, and blood-vessel; he must grasp the whole process of structural development. Histology and embryology are thus essential aspects of anatomical study. No treatment of the subject including these is possible within the time-limits of the modern medical curriculum unless previous training in general biology has equipped the student with the necessary fundamental conceptions, knowledge, and technical dexterity. It has just been stated that physiology presupposes anatomy on lines involving antecedent training in biology; it leans just as hard on chemistry and physics. The functional activities of the body propound questions in applied chemistry and applied physics. Nutrition and waste—what are these but chemical problems within the realm of biology? The mechanism of circulation, of seeing, or hearing—what are these but physical problems under the same qualifications? The normal rhythm of physiological function must then remain a riddle to students who cannot think and speak in biological, chemical, and physical language.

All this is, however, only preliminary. The physician's concern with normal process is not disinterested curiosity; it is the starting-point of his effort to comprehend and to master the abnormal. Pathology and bacteriology are the sciences concerned with abnormalities of structure and function and their causation. Now the agents and forces which invade the body to its disadvantage play their game, too, according to law. And to learn that law one goes once more to the same fundamental sciences upon which the anatomist and the physiologist have already freely drawn,—*viz.*, biology, physics, and chemistry.

Nor do these apparently recondite matters concern only the experimenting investigator, eager to convert patiently acquired knowledge of bacterial and other foes into a rational system of defense against them. For the practical outcome of such investigation is not communicable by rote; it cannot be reduced to prescriptions for mechanical use by the unenlightened practitioner. Modern medicine cannot be formulated in quiz-compends; those who would employ it must trouble to understand it. Moreover, medicine is developing with beneficent rapidity along these same biological and chemical lines. Is our fresh young graduate of five and twenty to keep abreast of its progress? If so, he must, once more, understand; not otherwise can he adopt the new agents and new methods issuing at intervals from each of a dozen fertile laboratories; for rote has not future: it stops where it is. "There can be no doubt," said Huxley, "that the future of pathology and of therapeutics, and *therefore of practical medicine*, depends upon the extent to which those who occupy themselves with these subjects are trained in the methods and impregnated with the fundamental truths of biology."[3] Now the medical sciences proper—anatomy, physiology, pathology, pharmacology—already crowd the two years of the curriculum that can be assigned to them; and, in so doing, take for granted the more fundamental sciences—biology, physics, and chemistry—for which there is thus no adequate opportunity within the medical school proper. Only at the sacrifice of some essential part of the medical curriculum—and for every such sacrifice the future patients pay—can this curriculum be made to include the preliminary subjects upon which it presumes.

From the foregoing discussion, these conclusions emerge: By the very nature of the case, admission to a really modern medical school must at the very least depend on a competent knowledge of chemistry, biology,[4] and physics. Every departure from this basis is at the expense of medical training itself. From the exclusive standpoint of the medical school it is immaterial where the student gets the instruction. But it is clear that if it is to become the common minimum basis of medical education, some recognized and organized manner of obtaining it must be devised: it cannot be left to the initiative of the individual without greatly impairing its quality. Regular provision must therefore be made at a definite moment of normal educational progress. Now the requirement above agreed on is too extensive and too difficult to be incorporated in its entirety within the high school or to be substituted for a considerable portion of the usual high school course; besides, it demands greater maturity than the secondary school student can be credited with except towards the close of his high school career. The possibility of mastering the three sciences outside of school may be dismissed without argument. In the college or technical school alone can the work be regularly, efficiently, and surely arranged for. The requirement is therefore necessarily a college requirement, covering two years, because three laboratory courses cannot be carried through in a briefer period,—a fortunate circumstance, since it favors the student's simultaneous development along other and more general lines. It appears, then, that a policy that at the outset was considered from the narrow standpoint of the medical school alone shortly involves the abandonment of this point of view in favor of something more comprehensive. The preliminary requirement for entrance upon medical education must therefore be formulated in terms that establish a distinct relation, pedagogical and chronological, between the medical school and other educational agencies. Nothing will do more to steady and to improve the college itself than its assumption of such definite functions in respect to professional and other forms of special training.

So far we have spoken explicitly of the fundamental sciences only. They furnish, indeed, the essential instrumental basis of medical education. But the instrumental minimum can hardly serve as the permanent professional minimum. It is even instrumentally inadequate. The practitioner deals with facts of two categories. Chemistry, physics, biology enable him to apprehend one set; he needs a different apperceptive and appreciative apparatus to deal with other, more subtle elements. Specific preparation is in this direction much more difficult; one must rely for the requisite insight and sympathy on a varied and enlarging cultural experience. Such enlargement of the physician's horizon is otherwise important, for scientific progress has greatly modified his ethical responsibility. His relation was formerly to his patient—at most to his patient's family; and it was almost altogether remedial. The patient had something the matter with him; the doctor was called in to cure it. Payment of a fee ended the transaction. But the physician's function is fast becoming social and preventive, rather than individual and curative. Upon him society relies to ascertain, and through measures essentially educational to enforce, the conditions that prevent disease and make positively for physical and moral well-being. It goes without saying that this type of doctor is first of all an educated man.

How nearly our present resources—educational and economic—permit us to approach the standards above defined is at bottom a question of fact to be investigated presently. We have concluded that a two-year college training, in which the sciences are "featured," is the minimum basis upon which modern medicine can be successfully taught. If the requisite number of physicians cannot at one point or another be procured at that level, a temporary readjustment may be required; but such an expedient is to be regarded as a makeshift that asks of the sick a sacrifice that must not be required of them a moment longer than is necessary. Before accepting such a measure, however, it is exceedingly important not to confuse the basis on which society can actually get the number of doctors that it needs with the basis on which our present number of medical schools can keep going. Much depends upon which end we start from.

CHAPTER IX
Reconstruction

The necessity of a reconstruction that will at once reduce the number and improve the out-put of medical schools may now be taken as demonstrated. A considerable sloughing has already occurred. It would have gone further but for the action of colleges and universities which have by affiliation obstructed nature's own effort at readjustment. Affiliation is now in the air. Medical schools that have either ceased to prosper, or that have become sensitive to the imputation of proprietary status or commercial motive, seek to secure their future or to escape their past by contracting an academic alliance. The present chapter undertakes to work out a schematic reconstruction which may suggest a feasible course for the future. It is not supposed that violent measures will at once be taken to reconstitute the situation on the basis here worked out. A solution so entirely suggested by impersonal considerations may indeed never be reached. But legislators and educators alike may be assisted by a theoretical solution to which, as specific problems arise, they may refer.

This solution deals only with the present and the near future,—a generalization, at most. In the course of the next thirty years needs will develop of which we here take no account. As we cannot foretell them, we shall not endeavor to meet them. Certain it is that they will be most effectively handled if they crop up freely in an unencumbered field. It is therefore highly undesirable that superfluous schools now existing should be perpetuated in order that a subsequent generation may find a means of producing its doctors provided in advance. The cost of prolonging life through this intervening period will be worse than wasted; and an adequate provision at that moment will be embarrassed by inheritance and tradition. Let the new foundations of that distant epoch enjoy the advantage of the Johns Hopkins, starting without handicap at the level of the best knowledge of its day.

The principles upon which reconstruction would proceed have been established in the course of this report:

1) A medical school is properly a university department; it is most favorably located in a large city, where the problem of procuring clinical material, at once abundant and various, practically solves itself. Hence those universities that have been located in cities can most advantageously develop medical schools.

2) Unfortunately, however, our universities have not always been so placed. They began in many instances as colleges or something less. Here a supposed solicitude for youth suggested an out-of-the-way location; elsewhere political bargaining brought about the same result. The state

universities of the south and west, most likely to enjoy sufficient incomes, are often unfortunately located: witness the University of Alabama at Tuscaloosa, of Georgia at Athens, of Mississippi at Oxford, of Missouri at Columbia, of Arkansas at Fayetteville, of Kansas at Lawrence, of South Dakota at Vermilion; and that experience has taught us nothing is proved by the recent location of the State University of Oklahoma at Norman. Some of these institutions are freed from the necessity of undertaking to teach medicine by an endowed institution better situated; in other sections the only universities fitted by their large support and their assured scientific ideals to maintain schools of medicine are handicapped by inferiority of locations. We are not thereby justified in surrendering the university principle. Experience, our own or that of Germany, proves, as we have already pointed out, that the difficulty is not insuperable. At relatively greater expense, it is still feasible to develop a medical school in such an environment: there is no magnet like reputation; nothing travels faster than the fame of a great healer; distance is an obstacle readily overcome by those who seek health. The poor as well as the rich find their way to shrines and healing springs. The faculty of medicine in these schools may even turn the defect of situation to good account; for, freed from distraction, the medical schools at Iowa City and Ann Arbor may the more readily cultivate clinical science. An alternative may indeed be tried in the shape of a remote department. The problem in that case is to make university control real, to impregnate the distant school with genuine university spirit. The difficulty of the task may well deter those whose resources are scanty or who are under no necessity of engaging in medical teaching. As we need many universities and but few medical schools, a long-distance connection is justified only where there is no local university qualified to assume responsibility. A third solution—division—may, if the position taken in previous chapters is sound, be disregarded in the final disposition.[5]

3) We shall assign only one school to a single town. As a matter of fact, no American city now contains more than one well supported university,[6]—and if we find it unnecessary or impolitic to duplicate local university plants, it is still less necessary to duplicate medical schools. The needless expense, the inevitable shrinkage of the student body, the difficulty of recruiting more than one faculty, the disturbance due to competition for hospital services, argue against local duplication. It is sometimes contended that competition is stimulating: Tufts claims to have waked up Harvard; the second Little Rock school did undoubtedly move the first to spend several hundred dollars on desks and apparatus. But competition may also be demoralizing: the necessity of finding students constitutes [for, Ed.] medical schools which ought to elevate standards, the main obstacles to their elevation: witness the attitude of several institutions in

Boston, New York, Philadelphia, Baltimore, and Chicago. Moreover, local competition is a stimulus far inferior to the general scientific competition to which all well equipped, well conducted, and rightly inspired university departments throughout the civilized world are parties. The English have experimented with both forms,—a single school in the large provincial towns, a dozen or more in London,—and their experience inclines them to reduce as far as possible the number of London schools. Amalgamation has already taken place in certain American towns: the several schools of Cincinnati, of Indianapolis, and of Louisville have all recently "merged." This step is easy enough in towns where there is either no university or only one university. Where there are several, as in Chicago, Boston, and New York, the problem is more difficult. Approached in a broad spirit it may, however, prove not insoluble; cooperation may be arranged where several institutions all possess substantial resources: universities of limited means can retire without loss of prestige,—on the contrary, the respect in which they are held must be heightened by any action dictated by conscientious refusal to continue a work that they are in no position to do well.

4) A reconstruction of medical education cannot ignore the patent fact that students tend to study medicine in their own states, certainly in their own sections. In general, therefore, arrangements ought to be made, as far as conditions heretofore mentioned permit, to provide the requisite facilities within each of the characteristic state groups. There is the added advantage that local conditions are thus heeded and that the general profession is at a variety of points penetrated by educative influences. New Orleans, for example, would cultivate tropical medicine; Pittsburgh, the occupational diseases common in its environment. In respect to output, we may once more fairly take existing conditions into account. We are not called on to provide schools enough to keep up the present ratio. As we should in any case hardly be embarrassed for almost a generation in the matter of supply, we shall do well to produce no doctors who do not represent an improvement upon the present average.

The principles above stated have been entirely disregarded in America. Medical schools have been established regardless of need, regardless of the proximity of competent universities, regardless of favoring local conditions. An expression of surprise at finding an irrelevant and superfluous school usually elicits the reply that the town, being a "gateway" or a "center," must of course harbor a "medical college." It is not always easy to distinguish "gateway" and "center:" a center appears to be a town possessing, or within easy reach of, say 50,000 persons; a gateway is a town with at least two railway stations. The same place may be both,—in which event the argument is presumably irrefragable. Augusta, Georgia, Charlotte, North Carolina, and Topeka, Kansas, are "centers," and as such are logical abodes of medical instruction. Little Rock, St. Joseph, Memphis, Toledo, Buffalo, are "gateways." The argument, so dear to local pride, can best be refuted by being pursued to its logical conclusion. For there are still forty-eight towns in the United States with over 50,000 population each, and no medical schools: we are threatened with forty-eight new schools at once, if the contention is correct. The truth is that the fundamental, though of course not sole, consideration is the university, provided its resources are adequate; and we have fortunately enough strong universities, properly distributed, to satisfy every present need without serious sacrifice of sound principle. The German Empire contains eighty-four cities whose population exceeds 50,000 each. Of its twenty-two medical schools, only eleven are to be found in them: that is, it possesses seventy-three gateways and centers without universities or medical schools. The remaining eleven schools are located in towns of less than 50,000 inhabitants, a university town of 30,000 being a fitter abode for medical study than a non-university town of half a million, in the judgment of those who have best succeeded within it.

That the existing system came about without reference to what the country needed or what was best for it may be easily demonstrated. Between 1904 and 1909 the country gained certainly upwards of 5,000,000 in population; during the same period the number of medical students actually decreased from 28,142 to 22,145, i.e., over 20 percent. The average annual production of doctors from 1900 to 1909 was 5222; but last June the number dropped to 4442. Finally, the total number of medical colleges which reached its maximum—166[7]—in 1904 has in the five years since decreased about 10 percent. Our problem is to calculate how far tendencies already observable may be carried without harm.

We have calculated that the south requires for the next generation 490 new doctors annually, the rest of the country, 1500. We must then provide machinery for the training of about 2000 graduates in medicine yearly. Reckoning fatalities of all kinds at ten percent per annum, graduating classes of 2000 imply approximately junior classes of 2200, sophomore classes of 2440, freshman classes aggregating 2700,—something over 9000 students of medicine. Thirty medical schools, with an average enrolment of 300 and average graduation classes of less than 70, will be easily equal to the task. As many of these could double both enrolment and output without danger, a provision planned to meet present needs is equally sufficient for our growth for years to come. It will be time to devise more schools when the productive limit of those now suggested shall come in sight.

For the purpose here in mind, the country may be conceived as divided into several sections, within each of which, with due regard to what it now contains, medical schools enough to satisfy its needs must be provided.[8] Pending the fuller development of the states west of the Mississippi, the section east will have to relieve them of part of their responsibility. The provisional nature of our suggestions is thus obvious; for as the west increases in population, as its universities grow in number and strength, the balance will right itself: additional schools will be created in the west and south rather than in the north and east. It would of course be unfortunate to over-emphasize the importance of state lines. We shall do well to take advantage of every unmistakably favorable opportunity so long as we keep within the public need; and to encourage the freest possible circulation of students throughout the entire country.

[Seven pages of suggested regional reductions and mergers have been removed here, along with maps of then existing and suggested locations for medical schools. Ed.]

Reduction of our 155 medical schools to 31 would deprive of a medical school no section that is not capable of maintaining one. It would threaten no scarcity of physicians until the country's development actually required more than 3500 physicians annually, that is to say, for a generation or two, at least. Meanwhile, the outline proposed involves no artificial standardization: it concedes a different standard to the south as long as local needs require; it concedes the small town university type where it is clearly of advantage to adhere to it; it varies the general ratio in thinly settled regions; and, finally, it provides a system capable without overstraining of producing twice as many doctors as suppose the country now to need. In other words, we may be wholly mistaken in our figures without in the least impairing the feasibility of the kind of renovation that has been outlined; and every institution arranged for can be expected to make some useful contribution to knowledge and progress.

The right of the state to deal with the entire subject in its own interest can assuredly not be gainsaid. The physician is a social instrument. If there were no disease, there would be no doctors. And as disease has consequences that immediately go beyond the individual specifically affected, society is bound to protect itself against unnecessary spread of loss or danger. It matters not that the making of doctors has been to some extent left to private institutions. The state already makes certain regulations; it can by the same right make others. Practically the medical school is a public service corporation. It is chartered by the state; it utilizes public hospitals on the ground of the social nature of its service. The medial school cannot then escape social criticism and regulation. It was left to itself while society knew no better. But civilization consists in the legal registration of gains won by science and experience; and science and experience have together established the terms upon which medicine can be most useful. "In the old days," says Metchnikoff,[9] "anyone was allowed to practise medicine, because there was no medical science and nothing was exact. Even at the present time among less civilized people, any old woman is allowed to be a midwife. Among more civilized races, differentiation has taken place and childbirths are attended by women of special training who are midwives by diploma. In case of nations still more civilized, the trained midwives are directed by obstetric physicians who have specialized in the conducting of labor. This high degree of differentiation has arisen with and has itself aided the progress of obstetrical science." Legislation which should procure for all the advantage of such conditions as is now possible would speedily bring about a reconstruction quite as extensive as that described.

Such control in the social interest inevitably encounters the objection that individualism is thereby impaired. So it is, at that level; so it is intended. The community through such regulation undertakes to abridge the freedom of particular individuals to exploit certain conditions for their personal benefit. Bur its aim is thereby to secure for all others more freedom at a higher level. Society forbids a company of physicians to pour out upon the community a horde of ill trained physicians. Their liberty is indeed clipped. As a result, however, more competent doctors being trained under the auspices of the state itself, the public health is improved; the physical well-being of the wage-worker is heightened; and a restriction put upon the liberty, so-called, of a dozen doctors increases the effectual liberty of all other citizens. Has democracy, then, really suffered a setback? Reorganization along rational lines involves the strengthening, not the weakening, of democratic principle, because it tends to provide the conditions upon which well-being and effectual liberty depend.

Source

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CHAPTER 21

JOSEPH GOLDBERGER
(1874–1929)

Once you've made a medical discovery, you have to convince the public of its merits—a task that is not always easy because of social or moral beliefs.

—Alan Kraut, *The Unwelcome Messenger*, NIH Lecture on Goldberger, 1997

Joseph Goldberger was born in Geralt, Hungary (now Giraltovce, Slovakia), on July 16, 1874, the youngest of six siblings. His parents were sheepherders, but their family lost their livelihood owing to a disease of their flocks. In 1883, the family migrated to the United States, settling on the Lower East Side (Pitt Street) of Manhattan and opening a grocery store where Joseph served as the delivery boy. Three new siblings were soon added to the family. At age 16, Joseph entered City College in New York to study engineering, but a lecture at Bellevue Hospital Medical College by Dr. Austin Flint Jr. changed his mind. Goldberger transferred and earned a medical degree from that institution in 1895.

Goldberger's private practice in Wilkes Barre, Pennsylvania, lasted only two years as he did not find it intellectually challenging. In 1899, he successfully competed for a position in the Marine Hospital Service, a government agency established by Congress in 1798 to care for sick merchant seamen, with a focus on containing epidemics at national ports of entry. The Marine Hospital Service was renamed the Public Health Service in 1902, and in 1912, Congress expanded its mandate to include investigating human diseases.

As an assistant surgeon earning $1,600 a year, Goldberger's initial posting was to the port of New York City, where he examined immigrants. However, Goldberger's epidemiology skills soon manifested, and between 1902 and 1906 he was assigned several infectious disease epidemic investigations for the Public Health Service. He followed yellow fever into Mexico, Puerto Rico, Mississippi, and Louisiana and contracted the disease himself. His efforts fighting yellow fever earned him promotion to the rank of passed assistant surgeon in 1904. In 1906, Goldberger married Mary Farrar, grandniece of Jefferson Davis, the president of the Confederacy. Goldberger was then assigned to the Hygienic Laboratory in Washington.

When Goldberger was sent to investigate an outbreak of typhoid fever, he contracted the disease. The same was true when he went to Texas to study dengue fever and when he went to Mexico to battle typhus. In 1909, he published his research on Shamberg's disease, a serious skin condition caused by the acarine mite that infested the straw mattresses commonly used by the urban poor. His work with Dr. John F. Anderson determined that "Brill's disease" was identical to typhus.

In 1914, Goldberger was in Detroit working on an outbreak of diphtheria when the surgeon general assigned him the task of investigating pellagra, an epidemic disease throughout the country. Pellagra hit the South particularly hard while it was still recovering from the poverty left by defeat in the American Civil War. Conventional wisdom held that pellagra was an infectious disease. Through extensive observations, Goldberger became convinced that the cause of this disease was in the diet, not from an infection. Those who were restricted to a poor diet of cornbread and molasses were the most likely to get the disease. He set out dietary experiments with volunteers at a Mississippi prison, attempting to find conclusive evidence that poor nutrition caused pellagra. While the experiments did show the link, no causative agent was found, and his results were rejected. Goldberger died on January 17, 1929, from renal cell carcinoma.

A Note on the Text

Goldberger's *Etiology* describes the relationship between nutrition and pellagra. Readers will find the paper terse, without the extensive argument found in papers of the Sanitary Movement. While the results of the experiments clearly linked diet to the disease, the missing ingredient that brought on the disease was not able to be determined, and his results were rejected by the general public.

Reasons for rejection include the fact that Goldberger was a Northerner doing experiments in the South. Second, he was a Jew. Finally, the public found it inexplicable that diet could cause disease. It was not until 1937 that Conrad A. Elevjhem found that a nicotinic acid (vitamin B3 or niacin) deficiency in dogs caused black tongue disease. At the same time, Tom Spies, Marion Blankenhorn, and Clark Cooper began human studies in Alabama and Cincinnati, firmly establishing that niacin could cure pellagra in humans. Their efforts were recognized by *Time* magazine, which dubbed them the 1938 "Men of the Year" for comprehensive science. Later, Tulane University scientists discovered that the amino acid tryptophan was a precursor to niacin. When tryptophan was added to commercial foods, especially bread, it prevented further pellagra epidemics. Today, pellagra is a rare disease, except during times of famine and displacement.

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The Etiology of Pellagra: The Significance of Certain Epidemiological Observations With Respect Thereto (1914)

The writer desires to invite attention to certain observations recorded in the literature of pellagra the significance of which appears entirely to have escaped attention.

At the National Conference on Pellagra held in Columbia, S.C., November 3, 1909, Siler and Nichols in their paper on the "Aspects of the pellagra problem in Illinois" stated that certain facts "would seem to indicate that the exciting cause of the disease is present within the institution" (Peoria State Hospital), and add that "at the same time no nurses, attendants, or employees have shown the disease."

Manning, medical superintendent of the asylum at Bridgetown, Barbados, on the same occasion, in arguing against the identity of a disease that he called psilosis pigmentosa, with pellagra, but which undoubtedly is this disease, states that he had never seem it develop in an attendant.

At the same conference Mobley, from the Georgia State Sanitarium, in the course of his discussion of the relation of pellagra to insanity, presents data showing that at the Georgia State Sanitorium a considerable proportion of the cases of pellagra develop in inmates who have been residents therein for considerable periods, mentioning one case in an inmate after 10 years' residence. In this connection he remarks, what must have struck him, as it no doubt must have appeared to Siler and Nichols at the Illinois institution, as a curious fact, that "so far as can be ascertained there has never been a case of pellagra to develop among the nurses, white or colored, while employed as such in the Georgia State Sanitarium."

Sambon (1910) in his "Progress report" states that in Italy "no precautions are ever taken to avoid propagation of the malady in any of the *pellagrosari, locande sanitarie*, hospitals, insane asylums, and other institutions in which very numerous pellagrins are collected every year. Long experience has taught that there is no danger whatever of transmission from the sick to the healthy in any collective dwelling within urban precincts."

Sambon's statement is confirmed by Lavinder, who in a personal communication states that on careful inquiry while visiting a large *pellagrossario* near Venice, one in which some 300 to 500 pellagrins are constantly present and cared for by a large number of Sisters of Charity and other employees, he was assured that no employee had ever developed the disease while at the institution.

The results of personal inquiry at some of our State asylums in which pellagra occurs confirm the reported observations above cited. Thus at the South Carolina State Hospital for the Insane, where Babcock (1910 Ann. Rept.) states that cases of pellagra develop in patients who have been there for years, no case so far as the writer was able to ascertain has occurred in the nurses or attendants. It may be of interest to recall in this connection that in his annual report for 1913 Babcock states that a total of about 900 pellagrins had been admitted to his institution during the preceding six years.

At the State hospital for the insane at Jackson, Miss., there have been recorded 98 deaths from pellagra for the period between October 1, 1909, and July 1, 1913. At this institution cases of institutional origin have occurred in inmates. Dr. J. C. Herrington, assistant physician and pathologist, told me at the time of my visit of a case in an inmate after 15 and in another after 20 years' residence at the institution. No case, so far as I was able to learn, has developed in a nurse or attendant, although since January 1, 1909, there have been employed a total of 126 who have served for periods of from 1 to 5 years.

In considering the significance of the foregoing observations it is to be recalled that at all of these institutions the ward personnel, nurses, and attendants spend a considerable proportion of the 24 hours, on day and night duty, in close association with the inmates; indeed at many of these institutions, for lack of a separate building or special residence for the nurses, these live right in the ward with and of necessity under exactly the same conditions as the inmates.

It is striking therefore that although many inmates develop pellagra after varying periods of institutional residence, some even after 10 to 20 years of institutional life, and therefore it seems permissible to infer, as the result of the operation within the institution of the exciting cause or causes, yet nurses and attendants living under identical conditions appear uniformly to be immune. If pellagra be a communicable disease, why should there be this exemption of the nurses and attendants?

To the writer this peculiar exemption or immunity is inexplicable on the assumption that pellagra is communicable. Neither "contact" in any sense nor insect transmission is capable of explaining such a phenomenon, except on the assumption of an incubation or latent period extending over 10 to 20 years. In support of such an assumption there exists, so far as the writer is aware, no satisfactory evidence.

The explanation of the peculiar exemption under discussion will be found in the opinion of the writer in a difference in the diet of the two groups of residents. At some of the institutions there is a manifest difference in this regard; in others none in apparent.

The latter would seem to be a fatal objection to this explanation, but a moment's consideration will show that such is not necessarily the case. The writer from, personal observation has found that although the nurses and attendants may apparently receive the same food, there is nonetheless a difference in that the nurses have the privilege—which they exercise—of selecting the best and the greatest variety for themselves. Moreover, it must not be overlooked that nurses and attendants have opportunities for supplementing their institutional dietary intake that the inmates as a rule have not.

In this connection brief reference must be made to two other epidemiological features of pellagra. It is universally agreed (1) that this disease is essentially rural, and (2) associated with poverty. Now there is plenty of poverty and all its concomitants in all cities, and the question naturally arises why its greater predilection for rural poverty? What important difference is there between the elements of poverty in our slums and those of poverty in rural dwellers? It is not the writer's intention to enter at this time into a detailed discussion of these questions; he wishes to point out one difference only. This difference relates to the dietary. Studies of urban and rural dietaries (Wait—Office of Experiment Stations, Bull. 221, 1909) have shown that on the whole the very poor of cities have a more varied diet, than the poor in rural sections. "Except in extreme cases, the city poor . . . appear to be better nourished than the mountaineers" of Tennessee.

With regard to the question of just what in the dietary is responsible, the writer has no opinion to express. From a study of certain institutional dietaries, however, he has gained the impression that vegetables and cereals form a much greater proportion in them than they do in the dietaries of well-to-do people; that is, people who are not, as a class, subject to pellagra.

The writer is satisfied that the consumption of corn or corn products is not essential to the production of pellagra, but this does not mean that corn, the best of corn, or corn products, however nutritious and however high in caloric value they may be, are not objectionable when forming of themselves or in combination with other cereals and with vegetables, a large part of the diet of the individual.

In view of the great uncertainty that exists as to the true cause of pellagra, it may not be amiss to suggest that pending the final solution of this problem it may be well to attempt to prevent the disease by improving the dietary of those among whom it seems most prevalent. In this direction I would urge the reduction in cereals, vegetable, and canned foods that enter to so large an extent into the dietary of many of the people in the South and an increase in the fresh animal food component, such as fresh meats, eggs, and milk.

It may be of interest to add that intensive studies along the lines so strongly suggested by the observations above considered are being prosecuted by several groups of workers of the United States Public Health Service.

Source

Goldberger, J. "The Etiology of Pellagra." *Public Health Reports* 29 (1914): 1683–1686.

MARGARET SANGER
(1879–1966)

No woman can call herself free who does not own and control her body. No woman can call herself free until she can choose consciously whether she will or will not be a mother.

—Margaret Sanger, *Women and the New Race*, 1920

Born in Corning, New York, in 1879 (some sources claim that she was born in 1883), Margaret Louise Higgins was the sixth of 11 children. Little is written about Margaret's father, but her mother, Anne Purcell Higgins, was a devout Roman Catholic. She was also a sickly woman who died of tuberculosis and cervical cancer at the age of fifty, after 18 total pregnancies. The health and child-bearing burden that defined her mother's life was never lost on Margaret.

In 1897, Margaret was sent to a boarding school, Claverack College, in Hudson, New York. In 1899, the family could no longer afford her tuition, so Margaret returned home only to watch over her mother's final days. After her mother's death, Margaret enrolled in a nursing program at a hospital in White Plains, New York, where she completed two of three years of nursing training. In 1902, Margaret married architect William Sanger (the marriage is alternately reported as taking place in 1900). It was then that her life began to eerily parallel that of her mother. Margaret was diagnosed with tuberculosis; she gave birth to a son the following year, then in rapid succession bore a second son and a daughter. William encouraged Margaret to stay home and raise their children rather than pursuing a career, and she complied.

A house fire destroyed their home in 1912, and the Sanger family moved to New York City, where the couple became involved in radical politics. Margaret began working as a practical nurse in the lower East Side slums of Manhattan, where she saw the plight of poor women who were caught up in ceaseless childbearing. These women had no access to information about contraception because it was suppressed by both physicians and the clergy. Sanger knew that women of means could access such information; they could even buy condoms and spermicidal products. She chafed to such apparent injustice and began writing a column for the *New York Call* titled "What Every Girl Should Know."

In 1913, Margaret and William Sanger separated, though the divorce was not final until 1920. Margaret traveled to Paris, where she conducted research on European contraceptive methods, returning to the United States convinced that women could not only take control of their bodies; they could be the primary agents of social and economic change. In 1914, she launched an eight-page monthly newsletter, *The Woman Rebel*, in which she argued for sexual and reproductive autonomy for women. It is in this publication that she first coined the term *birth control*. The authorities considered the material in the newsletter obscene, and Margaret was indicted for using the postal system for its distribution. To avoid prosecution, she fled to Europe, traveling under the name "Bertha Watson." When the ship reached international waters, Margaret cabled her publisher in New Jersey, directing them to distribute 100,000 copies of her pamphlet *Family Limitation*. Although William remained in New York to care for their three children, he became the victim of a sting operation and was arrested and jailed for 30 days for distributing 1 copy of the pamphlet to an agent of the Comstock Commission.

Margaret Sanger remained in Europe for a year, having several affairs—variously noted as with author H. G. Wells, sexual psychologist Havelock Ellis, and Spanish educator, anarchist, and writer Lorenzo Portet. Sanger returned to the United States to face prosecution in 1915, but within one month of her return, her five-year-old daughter Peggy died of pneumonia. Public sentiment supported the grieving mother, and all charges against her were dismissed.

Sanger's crusade for the plight of poor women moved beyond the written word to community action. She opened a family planning clinic with her sister, Ethyl Byrne, at 46 Amboy Street in the Brownsville section of Brooklyn on October 16, 1916. This first birth control clinic in the United States was raided by city policy only 9 days after opening its doors. Sanger served 30 days in jail but was vindicated in 1918 when the state appellate court found it legal for doctors to prescribe contraception.

More publications followed. In 1916, Sanger published "What Every Girl Should Know," followed in 1917 by "What Every Mother Should Know." She instituted a new monthly periodical, *The Birth Control Review and Birth Control News*, shortly afterward and regularly contributed health articles to *The Call*, a newspaper for the Socialist Party. In 1921, Sanger founded the American Birth Control League with Lothrop Stoddard and C. C. Little. In 1923, she married oil tycoon James Noah H. Slee and established the Clinical Research Bureau, the first legal birth control clinic in the United States. That same year, Sanger formed the National Committee on Federal Legislation for Birth Control and served as its president until 1937, when birth control under medical supervision was legalized in many states.

From 1916 on, Sanger lectured tirelessly, attempting to reach as many audiences as possible. Her efforts never ceased as she organized conferences, launched new publications, and founded multiple organizations focused on birth control. She served as president of the International Planned Parenthood Federation from 1952 to 1959 and advocated for the use of the birth control pill in the early 1960s. She remained a controversial and larger-than-life figure.

Sanger is credited with leading the modern birth control movement, but she is also condemned by many as an advocate of abortion. Sanger has also been charged with eugenics because many Planned Parenthood birth control clinics are selectively located in minority neighborhoods. Despite these contradictions, there is no question that Sanger impacted the lives of countless American women who may not even recognize her name. She died in 1966 in Tucson, Arizona, at age 86, several months after the landmark Supreme Court decision (*Griswold v. Connecticut*) legalized birth control for married couples in the United States.

A Note on the Text

Family Limitation was originally written for poor women, to empower them to take control of their own bodies and allow them to prevent pregnancy. The 16-page pamphlet contains information that the clergy, political authorities, and even feminists tried to suppress. There was the fear among the clergy that if the fear of pregnancy was abolished, adultery would become rampant. Politicians argued that separating women from their reproductive role would undercut definitions of womanhood and lead to the downfall of society. Feminists found the topic offensive and wanted to focus all of their energies on suffrage. They considered sexual freedom a distraction. Sanger believed, however, that unless women had control of their own bodies, any other social change was impossible.

The reader will find *Family Limitation* plainly written, concise, and frank in presentation. Early-twentieth-century readers found it perhaps too frank, and some were quick to label it obscene. Some readers today may agree, but all will have to acknowledge that this simple pamphlet sent a sea change through U.S. society.

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Family Limitation
(c. 1915)

Introduction

There is no need for any one to explain to the working men and women in America what this pamphlet is written for or why it is necessary that they should have this information. They know better than I could tell them, so I shall not try.

I have tried to give the knowledge of the best French and Dutch physicians translated into the simplest English, that all may easily understand.

There are various and numerous mechanical means of prevention which I have not mentioned here, mainly because I have not come into personal contact with those who have used them or could recommend them as entirely satisfactory.

I feel there is sufficient information given here, which if followed will prevent a woman from becoming pregnant unless she desires to do so.

If a woman is too indolent to wash and cleanse herself, and the man too selfish to consider the consequences of the act, then it will be difficult to find a preventive to keep the woman from becoming pregnant.

Of course, it is troublesome to get up to douche, it is also a nuisance to have to trouble about the date of the menstrual period. It seems inartistic and sordid to insert a pessary or a suppository in anticipation of the sexual act. But it is far more sordid to find yourself several years later burdened down with half a dozen unwished for children, helpless, starved, shoddily clothed, dragging at your skirt, yourself a dragged out shadow of the woman you once were.

Don't be over sentimental in this important phase of hygiene. The inevitable fact is that unless you prevent the male sperm from entering the womb, you are going to become pregnant. Women of the working class, especially wage workers, should not have more than two children at most. The average working man can support no more, and the average working woman can take care of no more in decent fashion. It has been my experience that more children are not really wanted, but that the women are compelled to have them either from lack of foresight or through ignorance of the hygiene of preventing conception.

It is only the workers who are ignorant of the knowledge of how to prevent bringing children in the world to fill jails and hospitals, factories and mills, insane asylums and premature graves, and who supply the millions of soldiers and sailors to fight battles for financiers and the ruling classes.

The working class can use direct action by refusing to supply the market with children to be exploited; by refusing to populate the earth with slaves.

It is also the one most direct method for you working women to help yourselves *today*.

Pass on this information to your neighbor, and comrade workers. Write out any of the following information which you are sure will help her, and pass it along where it is needed. Spread this important knowledge!

A Nurse's Advice to Women

Every woman who is desirous of preventing conception will follow this advice:

Don't wait to see if you do *not* menstruate (monthly sickness) but make it your duty to see that you *do*.

If you are due to be "sick" on the eighth of August, do not wait until the eighth to see, but begin as early as the fourth to take a good laxative for the bowels, and continue this each night until the eighth.

If there is the slightest possibility that conception may have taken place, take on these same nights before retiring, five or ten grains of quinine, with a hot drink. The quinine in capsule form is considered fresher, but if this is taken do not use alcoholic drinks directly after, as it hardens the capsules, thus delaying the action of the quinine.

By taking the above precautions you will prevent the ovum from making its nest in the lining of the womb.

Women of intelligence who refuse to have children until they are ready for them keep definite track of the date of their menstrual periods. A calendar should be kept, on which can be marked the date of the last menstruation, as well as the date when the next period should occur.

Women must learn to know their own bodies; and watch and know definitely how regular or irregular they are: if the period comes regularly every twenty-eight days (normal) or every thirty days as in the case of many young girls.

Mark it accordingly on your private calendar; do not leave it to memory or guess work.

Only ignorance and indifference will cause one to be careless in this most important matter.

A very good laxative (though it is a patent medicine) is Beechams Pills. Two of these, taken night and morning, four days before menstruation, will give a good cleansing of the bowels, and assist with the menstrual flow.

The American physicians may object to this advice because Beechams Pills are a patent medicine. But until they are willing to give open advice on this subject, we must resort to such as the least harmful, until such time as they do.

If a woman will give herself attention BEFORE the menstrual period arrives, she will almost never have any trouble, but if she neglects herself and waits to see if she “comes around,” she is likely to have difficulty.

It takes quinine from four to six days to bring about the desired results, and if one finds a longer time has elapsed, and the flow is not brought on, then the only remedy is an abortion. When once one has been convinced that an abortion is necessary, do not indulge in medicines of any kind. They only weaken the system, and require a much greater length of time to recuperate. Never allow a pregnancy to run over a month.

If you are going to have an abortion, make up your mind to it in the first stages, and have it done. On the other hand, there is often a feeling of the strongest desire to continue with the pregnancy. It is for each woman to decide this for herself, but act at once, whichever way you decide.

There is current among people an idea that conception can take place only at certain times of the month. For instance: ten days after the menstrual period, and ten or fourteen days before the next period. This is not to be relied upon at all, for it has been proven again and again that a woman can conceive at any time in the month. Do not depend upon this belief for there is no reliable foundation for it. There is also the knowledge that nursing after childbirth prevents the return of the menstrual flow for several months and conception does not take place. It is well not to depend upon this too much, especially after the fifth or sixth month, for often a woman becomes pregnant again without having “seen anything” or without her realizing that she has become pregnant. She thus finds herself with one at the breast and another in the womb. Use some preventive.

Again, it is believed that conception cannot take place if the woman lies upon her left side at the time of the act. It makes no difference which side she lies upon; she can become pregnant if the semen is not prevented from entering the womb.

Perhaps the commonest preventive excepting the use of the condom is “coitus interruptus,” or withdrawal of the penis from the vagina shortly before the ejaculation of the semen. No one can doubt that this is a perfectly safe method; and it is not considered so dangerous to the man as some authorities have formerly viewed it, but it requires a man of the strongest will-power to be certain that he has withdrawn before any of the semen has been deposited in the vagina. It is very difficult to determine exactly whether this has been done. The greatest objection to this is the evil effect upon the woman’s nervous condition. She has not completed her desire, she is under a highly nervous tension, her whole being is perhaps on the verge of satisfaction. She is then left in this dissatisfied state, which is far from humane. This does her injury. A mutual and satisfied sexual act is of great benefit to the average woman, the magnetism of it is health giving, and acts as a beautifier and tonic. When it is not desired on the part of the woman and she has no response, it should not take place. This is an act of prostitution and is degrading to the woman's finer sensibility, all the marriage certificates on earth to the contrary notwithstanding. When a woman desires the sexual act, and is completely satisfied, her whole being is built up and beautified through it, her form develops, her eyes become brighter, her health improves, color comes into her cheeks. All life is changed for her and would continue thus if it were not for the fact that she allows intercourse when she has no natural desire for it, and then allowing it, she is without means for prevention of conception, and is so throughout the act conscious and fearful of its consequences. Withdrawal on the part of the man should be substituted by some other means that does not injure the woman.

Douches and Their Importance

The most important part which every woman should learn in the methods of preventing conception is to cleanse herself thoroughly by means of the vaginal douche.

After the sexual act go as quickly as possible to the bath room and prepare a douche. Lie down upon the back in the bath tub. Hang the filled douche bag high over the tub, and let the water flow freely into the vagina, to wash out the male sperm which was deposited during the act.

Do not be afraid to assist the cleansing by introduction of the first finger with the tube and washing out the semen from the folds of the membrane. One can soon learn to tell by the feeling when it is sufficiently clean. It is said, that the French women are the most thorough douchers in the world, which helps greatly in keeping the organs in a clean and healthy condition, as well as preventing the male sperm from reaching the womb to mate with the ovum.

Following are some of the solutions to be used for the douche which when carefully used will kill the male sperm or prevent its entering the womb:

Lysol—is a brown oily liquid which added to water forms a clear soapy solution. One teaspoonful of Lysol to two quarts of water (warm) makes a good solution for douching. Mix into a pitcher or vessel before placing it in the bag.

Bichloride—Get the tablets blue or white from the druggist; the blue are less dangerous to have about because of the color. Always mix this solution thoroughly in a glass or pitcher before turning it into the bag. Never drop the tablet directly into the bag. One tablet to two quarts of water makes a splendid solution for preventive purposes.

Potassium Permanganate—This also makes a good solution, especially where there is a vaginal discharge. The special objection to this is that it stains the skin and clothing. This can be purchased in crystal form, and one teaspoonful dissolved in two quarts of water is the proper strength.

Carbolic acid solution is also used, but it is difficult to obtain this without a physician's prescription. It is no better than others herein mentioned not so difficult to obtain.

Chinosol is highly recommended as a vaginal douche, as being less injurious to the membranes than bichloride. It can be obtained from Parmele Pharmacal Co., 54 South St., New York.

Salt solution—Mix four tablespoonfuls of table salt in two quarts of warm or cold water and dissolve thoroughly.

Vinegar solution—Many peasants in Europe use vinegar as an antiseptic almost exclusively. One glassful to two quarts of water is the strength usually desired. Cider vinegar is preferred. Douche afterward with clear water.

Cold water douche—This will sometimes remove the semen quite effectively without the aid of an antiseptic. But as the semen can hide itself away in the wrinkled lining of the vaginal cavity, the cold water will only impede its progress for a time. As soon as the warmth of the body revives its activity, the semen continues on its journay to meet the ovum.

Every woman should possess a good two quart rubber douche bag called [a]fountain syringe. Hang it high enough to insure a steady direct flow.

Some women use the douche before the sexual act as a preventive.

Any astringent such as boric acid, alum, citric acid, hydrochlorate of quinine used in the solution. Only a pint of the solution is needed for this purpose, following the act a larger quantity is used as a cleanser. This can also be followed with the regular antiseptic douche.

The Use of the Condom or "Cots"

There is little doubt that a thorough douching of the genital passage with an antiseptic solution performed by skilled hands immediately after the sexual act would destroy the male sperm and nothing else would be necessary. But there is always the possibility that the sperm has entered the womb before the solution can reach it.

It is safer therefore to prevent the possibility of the contact of the semen and the ovum, by the interposition of a wall between them. One of the best is the condom or rubber "cot."

These are made of soft tissues which envelope the male organ (penis) completely and serve to catch the semen at the time of the act. In this way the sperm does not enter the vagina.

The condoms are obtainable at all drug stores at various prices. From two dollars a dozen for the skin gut tissues to one fifty a dozen for the rubber tissue. These are seamless, thin and elastic and yet tough; if properly adjusted will not break. Fear of breaking is the main objection to their use. If space has not been allowed for expansion of the penis, at the time the semen is expelled, the tissue is likely to split and the sperm finds its way into the uterus. The woman becomes pregnant without being conscious of it. If on the other hand care is given to the adjustment of the condom, not fitting it too close, it will act as one of the best protectors against both conception and venereal disease. Care must be exercised in withdrawing the penis after the act, not to allow the condom to peel off, thereby allowing the semen to pass into the vagina.

It is desirable to discard the condom after it has been used once. But as this is not always done, care must be taken to wash the condom in an antiseptic solution before drying it and placing it away for further use.

The condom is one of the most commonly known preventives in the United States. It has another value quite apart from prevention in decreasing the tendency in the male to arrive at the climax in the sexual act before the female.

There are few men and women so perfectly mated that the climax of the act is reached together. It is usual for the male to arrive at this stage earlier than the female, with the consequence that he is further incapacitated to satisfy her desire for some time after. During this time the woman is in a highly nervous condition, and it is the opinion of the best medical authorities that a continuous condition of this unsatisfied state brings on or causes disease of her generative organs, besides giving her a perfect horror and repulsion of the sexual act. Thousands of well meaning men ask the advice of physicians as to the cause of the sexual coldness and indifference in their wives. Nine times out of ten it is the fault of the man, who through ignorance and selfishness and inconsiderateness, has satisfied his own desire and promptly gone off to sleep. The woman in self defense has learned to protect herself from the long hours of sleepless nights and nervous tension by refusing to become interested.

The condom will often help in this difficulty. There are many girls who have had no education on this subject, no idea of the physiology of the act, who upon any contact of the semen have a disgust and repulsion from which it takes some time to recover. Much depends upon the education of the girl, but more depends upon the attitude of the man toward the relation.

The Pessary and the Sponge

Another form of prevention is the pessary (see cut). This is one of the most common preventive articles used in France as well as among the women of the middle and upper class in America. At one time the cost of these ranged up to seven dollars, as they were imported into this country from France. Today they are manufactured in this country, and may be had from fifty cents up to two dollars. The Mizpah is the name of one of the best and costs one dollar and a half at the reliable drug stores.

In my estimation this pessary is the surest method of absolutly [*sic*] preventing conception. I have known hundreds of women who have used it for years with the most satisfactory results. The trouble is women are afraid of their own bodies, and are of course ignorant of their physical construction. They are silly in thinking the pessary can go up too far, or that it could get lost, etc., etc., and therefore discard it. It can not get into the womb; neither can it get lost. The only thing it can do is to come out. And even that will give warning by the discomfort of the bulky feeling it causes, when it is out of place.

Follow the directions given with each box, and learn to adjust it correctly; one can soon feel that it is on right. After the pessary has been placed into the vagina deeply, it can be fitted well over the neck of the womb. One can feel it is fitted by pressing the finger around the soft part of the pessary, which should completely cover the mouth of the womb. If it is properly adjusted there will be no discomfort, the man will be unconscious that anything is used, and no germ or semen can enter the womb.

If the woman should fall asleep directly after no harm can happen, and it is not necessary to take a douche until the following morning. Take part or about a quart of an antiseptic douche BEFORE the pessary is removed; after removing it continue the douche and cleanse thoroughly.

Wash the pessary in clear cold water, dry well and place away in the box. One should last two years, if cared for.

I recommend the use of the pessary as the most convenient, the cheapest and the safest. Any nurse or doctor will teach one how to adjust it; then women can teach each other.

It is not advisable to wear the pessary all the time. Take it out after using, and wear it only when needed. A little experience will teach one that to place it is a simple matter.

Sponges

Sponges can also be had at the drug store. They have a tape attached to them to be conveniently removed. They should be soaked in an antiseptic solution for a few minutes before coitus and then introduced into the vagina as far up as they can be placed. Some physicians have recommended the use of the cotton plug, instead of the sponge, to be soaked in a solution of three per cent carbolic acid and glycerine, before the act. The male sperm is destroyed by the weakest solution of carbolic acid. Some of the peasants in Europe use the cotton plug soaked in vinegar for the same purpose, and find it satisfactory. In this country a boric acid solution has been used for the same purpose and with satisfactory results. Of course this requires a saturated solution, as, for instance, one teaspoonful of the powder to a cup of water stirred until dissolved.

Sponges and plugs can be recommended as perfectly safe, if followed by an antiseptic douche before the removal of the plug of sponge, thus preventing the sperm from entering the womb. The problem is: to kill the male sperm upon entering the vagina, or to wash it out or to kill it directly afterwards. A weak solution of alum may also be used for cotton plugs and sponges.

Vaginal Suppositories

These may be found at any reliable pharmacy. The majority of them are made from cocoa butter or gelatine, which makes it necessary that they be deposited in the vagina several minutes before the act, in order for them to melt. Special ingredients negate the effect of the male seed.

Any reliable druggist will make this up for you:

Boric acid, 1 dram
Salicylic acid, 10 grains
Quinine bisulphate, 2 drams
Chondrus jelly (KY), 2 oz.
Dispense in a collapsible tube.

Among other suppositories are the following:

Boric acid, 0.6 grams
Salicylic acid, 0.12 grams
Quinine bisulphate, 0.2 grams
Chinosol, 0.12 grams
Glycerine gelatine, 6.0 grams
Allow twenty minutes for melting.

Another form of suppository, which was recommended by a physician who charged a fee of $10 for the prescription, is the following:

Boric acid, 10 grains
Cocoa butter, 20 grains

Another suppository, which is the same as the well known Aseptikon, is the following:

Salicylic acid, 2 grains

Boric acid, 10 grains

Quin. purol (alkal), 1 grain

Chinosol, 2 grains

Cocoa butter, 90 grains

M. f suppos. glob No. 1

(Introduce into vagina three minutes before act.)

Practically all vaginal suppositories act as preventives, but the most commonly used is the Aseptikon, manufactured by the Chinosol Company. They are to be secured at any reliable druggist's upon demand. They should be kept in a cool place. They are not poisonous and cause no injury to the membranes. They are distributed 10 to a box costing 85 cents. The prescription quoted above can be made up more cheaply however.

It is interesting to note that in the rural districts in France, the peasant women make up their preventive suppositories themselves, placing them carefully away in glass jars. This is one of the recipes which has been used:

Gelatine, 1 part

Water, 2 parts

Glycerine, 5 parts

Bichloride of Quinine—one-half a part

Make this into a paste. Allow to spread out and solidify, then cut into pieces of 2 grammes [*sic*] each, wrap separately and put in a cool place (air-tight).

In some countries, preventive pastilles are used commonly. A type is compressed into pastilles. Injected in to the vagina a few minutes before coitis (the sexual act), the pastille melts into the secretions and forms an antiseptic preventive. Personal advice on the use of these is necessary before beginning to use them.

Source

Sanger, Margaret H. *Family Limitation*, 5th ed. New York: n.d. (on microform). The first edition (1914) is available online from the Sophia Smith Collection, Smith College, Northhampton, MA, at http://adh.sc.edu/dynaweb/MEP/ms/@Generic__BookTextView/3454;td=2;hf=0. The thirteenth edition (c. 1920) is available online from Planned Parenthood at www.pphouston.org/site/DocServer/FamilyLimitationSanger.pdf.

CHAPTER 23

ALICE HAMILTON
(1869–1970)

All this I had learned, but I had been assured by medical men, who claimed to know, that there was no phossy jaw in the United States because American match factories were so scrupulously clean.

—Alice Hamilton, *Exploring the Dangerous Trades: The Autobiography of Alice Hamilton, M.D.*, 1943

The second of four girls (one of five siblings), Alice Hamilton was born to Montgomery Hamilton and Gertrude (Pond) Hamilton in Fort Wayne, Indiana, on February 27, 1869. The family was one of the first to settle in Fort Wayne. Homeschooled as a child, she completed her medical studies at the University of Michigan, receiving her M.D. degree in 1893. Hamilton then completed internships in Minneapolis and Boston, followed by graduate studies in pathology and bacteriology in Munich and Leipzig. In 1895, she began further work with Simon Flexner (brother of Abraham Flexner [see Chapter 20]) at the Johns Hopkins University. In 1897, Hamilton moved to Chicago to begin a professorship in pathology at Northwestern University.

In 1897 Chicago was a hotbed for the social reform movement. Hamilton heard Jane Addams of Hull House speak and decided to join the movement, focusing on the problems faced by workers in industry. In 1907, as there was little occupational disease research taking place in the United States, Hamilton reviewed the literature from Europe. Her 1908 publication on the topic marked the start of occupational medicine in the United States. Governor Charles Deneen appointed Hamilton to a state commission on occupational diseases in 1910, and she began her work by examining workers' compensation claims in the lead industry. Hamilton found appalling work conditions that resulted in 578 cases of clear lead poisoning. Her work on lead poisoning among Illinois workers brought Hamilton to the attention of the U.S. Department of Labor where she served as a special investigator of industrial poisons for almost a decade.

In 1919, Hamilton became the first woman appointed to the faculty at the Harvard University Medical School. She had acquired considerable tact in dealing with the leaders of the industrial world, often charming them in the course of educating them about the occupational hazards present in the workplaces they managed. For example, she famously praised the heads of the National Lead Company for their efforts to protect their employees' health while observing that those workplaces were so "dangerous . . . that they would be closed by law in any European country."

Hamilton subsequently secured funds to study the metabolism of lead in the human body. Her findings showed that lead accumulates in bone, key to current efforts that use x-rays to assess total body burden of lead. They also showed that even a short-term exposure could result in long-term toxicity because lead cannot be quickly cleared by the body. The implications of this finding were profound, leading Hamilton and others, including the surgeon general, to oppose the addition of lead to gasoline, a practice that went nationwide beginning in the 1920s. It would be another six decades before lead was removed from gasoline in the United States.

Shortly before Hamilton retired from Harvard, Bradley Dewey, president of Dewey and Almy Chemical Company, wrote to the technical director of a firm that sold solvents: "I don't know what your company is feeling as of today about the work of Dr. Alice Hamilton on benzol [benzene] poisoning. I know that back in the old days some of your boys used to think that she was a plain nuisance and just picking on you for luck. But I have a hunch that as you have learned more about the subject, men like your good self have grown to realize the debt that society owes her for her crusade. I am pretty sure that she has saved the lives of a great many girls in canmaking plants and I would hate to think that you didn't agree with me."

After Hamilton's retirement in 1935 (still holding the rank of assistant professor), she continued to campaign for improving workers' health. She remained a consultant to the U.S. Department of Labor and, in 1943, published her autobiography, *Exploring the Dangerous Trades*. Hamilton died on September 22, 1970, in Hadlyme, Connecticut.

A Note on the Text

The selected reading comes from one of Hamilton's writings (published in 1919) dealing with lead exposure in women. Women of the time were often employed in the lead industries, though Hamilton's findings clearly showed the individual and societal costs resulting from the exposures associated with that employment. Although lead wreaked havoc on diverse systems in the body, it was its effects on the neurological system that were particularly troubling. Additionally, the possibility that pregnant women might inadvertently harm their fetus because of exposures at work triggered a variety of actions to eliminate those possibilities. Despite Hamilton's efforts, the challenges of lead in the workplace and in our environment persisted. The removal of lead in gasoline in the second half of the twentieth century helped reduce exposure to environmental lead, but we continue to discover its myriad toxicities even as exposure limits are reduced.

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Women in the Lead Industries
(1919)

Lead is by far the most common industrial poison, being responsible, according to Teleky,[1] for no less than 95 per cent of all the poisoning due to occupation. Layet[2] tells us that there are 111 occupations in France in which lead poisoning may occur, and at the time the Commission on Occupational Diseases in Illinois made its report (January, 1911), more than 70 occupations carried on in that State had been found to give rise to lead poisoning. Not only in Europe, but also in this country, industrial lead poisoning is a fairly familiar occurrence; but while in Europe women have been long employed in the lead trades and have suffered from the effects of lead, in America there have been but few women in such occupations, and lead poisoning among them is not at all common. Now, however, women are beginning to enter the occupations in which exposure to lead is inevitable, and it is very important to look carefully into the question of their employment in such occupations, and to determine whether it will be better to safeguard them by requiring employers to use every known means to reduce or eliminate the hazard of lead poisoning or by prohibiting the employment of women entirely in those occupations in which lead poisoning constitutes a considerable hazard.

What Is Industrial Lead Poisoning or Plumbism?

It is well to begin with a brief description of what lead does to the human system. When a person is exposed to lead-laden dust, or habitually eats his food with lead-soiled hands, the poison accumulates in his system and usually attacks the digestive tract and the blood first. It seldom happens nowadays that very acute or severe forms of lead poisoning are caused by exposure to lead during work. Some years ago men did at times develop severe symptoms of colic and even convulsions after only a few weeks' exposure to lead dust in the smelters or white-lead works, or in storage-battery plants, or in enameling sanitary ware. But the improvements in factory hygiene that have been made of late years have caused such distressing occurrences to become almost a thing of the past. A typical case of industrial lead poisoning comes on slowly. The man acquires a peculiar pallor which foremen and workmen soon learn to recognize, and which is caused partly by poverty of the blood because of destruction of the red blood corpuscles, and partly by contraction of the surface blood vessels. He begins to lose his appetite, especially for breakfast, for his mouth is foul when he first gets up and he may vomit if he tries to eat solid food. A peculiarly disagreeable sweetish taste is one of the early symptoms and increases the repugnance to food. Then he begins to lose strength, to get tired easily, and to have headaches, and pains in his limbs. He is almost always constipated, and this trouble increases till it may culminate in an attack of agonizing colic, with complete stoppage of the bowels. This so-called lead colic is what the men themselves and many physicians mean when they speak of acute lead poisoning, although a man has usually been suffering from lead poisoning for some time before the colic develops, and may be severely poisoned without ever having colic.

If, after an attack of acute lead colic, the man goes into more healthful work he will probably recover completely from the effects of the lead, though there are authorities who insist that even one attack leaves permanent, even if slight, changes in the blood vessels and in the liver. But if the man goes back to the same work, he develops the chronic form of lead poisoning, with perhaps recurrent attacks of colic. Chronic lead poisoning is essentially a disease of the blood vessels, leading to degeneration of the organs, the liver, kidneys, and heart especially, to atrophy of the digestive glands, and to premature old age.

With either the acute or the chronic form of lead poisoning there may be involvement of the nervous system. If the poison attacks the nerves and their endings, paralysis comes on, most commonly in the arms and wrists, sometimes in the shoulders and legs. If it attacks the brain there are severe headaches, disturbances of sight, dizziness or loss of consciousness, with convulsions which may be fatal, or which may be followed by mental derangement, more or less lasting.

These forms of lead poisoning are fairly easy to recognize, but there are others less clear. Indeed, there is no known poisonous substance which can give rise to such a variety of symptoms as lead. The rule laid down by specialists is that the occupation must always be considered in making a diagnosis of lead poisoning; that is, that if a patient is known to be working in lead, symptoms which would not be considered of great significance ordinarily must be taken seriously, because they may point to the beginning of lead poisoning. Oliver[3] says that pallor and sallowness, with metallic taste, especially in the morning, are common early symptoms. If the distaste for food is increasing, the individual should retire or be suspended from work, for it is one of the earliest indications that the resistance to lead has become diminished. Obstinate constipation and a sense of tiredness out of proportion to the amount of energy expended are also complained of.

The typical paralysis of the lead worker is known as "painter's palsy," because it is much more common in painters than in any other class of lead workers. It begins in the wrist, affecting the muscles that lift the hand, so that as it increases the hand tends to fall and hang helplessly, a condition known as "wrist-drop." The reason painters get wrist-drop is that they use the muscles of the wrist more than any others, and this overuse determines the localization of the palsy. Men who use other muscles, such as those of the shoulders or legs, get the paralysis in those muscles. Among white-lead workers weakness of the muscles of the leg and ankle is quite as common as weakness of the wrist, for these men do not make fine movements with the arms as painters do. They may also have a widely distributed paralysis involving the muscles of the trunk, back, and shoulders.

Lead poisoning of the central nervous system is a very distressing form, fortunately much less common now than it was a few years ago. It is more likely to develop after excessive exposure to lead dust, such as used to occur in the making of white lead and red lead, in mixing paste for storage batteries, in shaking lead enamel over red-hot bathtubs and sinks, in cleaning out the flues and bag houses of lead smelters, or even in putting lead glaze on pottery and tiles. The victim would suffer from something resembling an attack of epilepsy, or would become delirious and regain consciousness only partially or be out of his head for some days, or death might occur during the convulsion or during the unconsciousness that followed it.

Another form of lead poisoning of the central nervous system is very much more gradual in its development, and is seen chiefly in men who follow a lead trade for many years and suffer from a slow chronic poisoning. In such cases the blood vessels of the brain gradually harden, and the brain tissue is starved for blood, so that mental deterioration takes place, and the man become increasingly helpless and demented. It is among painters that this lead insanity most often occurs.

One more rather obscure form of lead poisoning should be mentioned, namely, the neurasthenia of chronic lead poisoning. According to Hirsch[4] this is quite a common condition, but one often not recognized by the ordinary physician. The victim suffers from obstinate headaches, from morning vomiting, and from pain that is not typical colic. He is depressed and irritable, sleeps badly, has tremors of the muscles, and is easily exhausted. Such cases are very apt to be regarded as ordinary neurasthenia, but they do not clear up unless the patient is taken away from lead work.

Lead lowers the resistance of the body to infections, especially such infections as tuberculosis and blood poisoning. Certain industries, as, for instance, the typographical trades, have always had a far larger proportion of tuberculosis than can be accounted for in any way except on the ground of a lowered resistance to tuberculosis caused by the absorption of lead. Suppurative inflammations also are more common among lead workers than among men not exposed to lead. The men themselves say that if a lead worker cuts himself the cut always festers, because the lead gets in and poisons the cut. What really occurs is that the germs of suppuration get in and the tissues, being affected by the lead, do not offer much resistance to them.

Individual Susceptibility

The most superficial study of lead poisoning in industry is enough to show how widely men differ in their susceptibility to this poison. Every foreman knows that there are men who can stand hardly any exposure to lead, while others can handle it for years with impunity. In even the worst factories there are at least one or two old workmen who have apparently breathed and swallowed lead compounds for from 25 to 40 years, and yet have remained apparently healthy. In one white-lead factory the records show that one of the employees began to feel symptoms of lead poisoning at the end of two weeks' time. He died of acute plumbism after five and a half months' work. In the same factory was a man who had worked in clouds of white-lead dust for 32 years, ever since he was a boy of 12, and had felt no ill effects.

Hirt, who had long experience in industrial lead poisoning, says that 20 to 30 per cent of all lead workers are not susceptible. Of the remaining 70 to 80 per cent a little over one-half (about 40 per cent of the whole number) sicken quickly, the others more slowly. This means that in every force of workmen there will be some who will be seriously injured by the poison if they remain in the industry, and who ought to be weeded out as soon as this fact is recognized, others who will not seem to be harmed by it at all, and still others who probably can be protected from poisoning if all proper precautions are taken, but who must be watched and examined by a physician occasionally to make sure that they are being adequately protected.

It is wholly inadmissible for employers to hold that because some employees of unusual resistance escape poisoning employers are not responsible for those who fall victims to it. Individual susceptibility plays a large part in many forms of sickness. If there is typhoid-infected water in a village of 500 inhabitants, there will not be 500 cases of typhoid fever, even though everyone drinks the water. There may not even be 50 cases. But for all the typhoid fever that does develop the infected water must be held responsible.

It may be well to give some illustrations of unusual susceptibility to lead poisoning. Such cases are not typical, of course, but they do occur often enough to make it necessary for us to take cognizance of them. For instance, painters usually do not develop symptoms of lead poisoning till after several years, sometimes even 15 or 20 years in the trade. Yet, out of 100 painters with lead poisoning whose histories were secured, 12 had sickened in less than a year's time. Among 167 cases of lead poisoning among smelters the majority were exposed for more than three months before they became poisoned, but 18 sickened after only one to three weeks' exposure. Among 186 sanitary-ware enamelers the majority had worked for more than five years before they were poisoned, but 21 had worked less than six months. A white-lead worker in Philadelphia went to a hospital with acute lead poisoning after three days' work emptying the dry pans in a very insanitary factory. Another very rapidly developing case was a bathtub enameler who came down with lead colic after four days' work.

Work in a tin shop is not regarded as involving much danger of lead poisoning, yet a record was obtained of one tin-shop worker who was treated not only for lead colic, but for lead rheumatism and anemia, after only two months' work. A storage-battery worker, who mixed lead oxides into paste by hand, was a tall and strongly built man, who said that he had never been sick in his life before; but after two weeks' work he began to feel ill, with loss of appetite, headache, and digestive disturbances, and at the end of 11 weeks he went to the hospital with typical lead colic.

There are other instances which show an unusually severe reaction to the entrance of lead into the system. A Hungarian found in a Pittsburgh hospital had worked for four years in a paint factory near Pittsburgh. He came to the hospital with colic, vomiting, and diarrhea. He was emaciated, dull, and apathetic, understanding what was said to him, but answering sluggishly. He was anemic, with 70 per cent hemoglobin; his limbs were soft and flabby; his muscles were wasted. The most serious change, however, was a general hardening of the arteries, one consequence of which had been hemorrhages into the retina, impairing his sight.

Another instance is that of a man who was employed in insanitary [*sic*] white-lead works for eight weeks. He also said that he had had no illness since childhood. He went to the hospital with colic, constipation, pains in his shoulders, arms, and legs, and increasing loss of power in the limbs. He remained in the hospital four weeks, and when discharged he had double wrist-drop and partial paralysis of the ankles. A strong, young Slavic workman was employed for five months pouring lead glaze over roof tiles. He began to feel sick, had a bad taste in his mouth, was nauseated, could not eat, felt weak, and "no good." He kept on working, however, for eight weeks more, and then one day, just as he had reached home after work, a violent attack of colic came on and he lost consciousness. This was followed by maniacal delirium for 48 hours, during which time he seemed to be in great pain. After this passed over he was dazed and confused, with loss of memory and impairment of vision, for about two weeks. His mind then cleared, but three months later he was still pale and had not recovered his strength.

It is a generally recognized fact, based on wide experience in the older countries, that the young of both sexes are more susceptible to lead poisoning than are fully developed men and women. Legge and Goadby[5] say that with regard to this: "The clinical conclusions of appointed surgeons in the various lead factories would be, we believe, that the susceptibility of young persons is at least twice that of adults, and there is some ground for supposing that the tissues of an adult, when growth has ceased, more readily adapt themselves to deal with the absorption and elimination of poisonous doses of lead than do the tissues of a young person."

Lead Poisoning in Women

British observers who have had much experience with women exposed to lead in the white-lead industry, and even more in the potteries, hold that women are more susceptible to lead than are men. Oliver[6] says: "So far as occupation exposure to lead is concerned, my opinion is (1) that women are more susceptible than men; (2) that while female liability is greatest between the ages of 18 and 23 years, that of men is later; and (3) that, while females rapidly break down in health under the influence of lead, men can work a longer time in the factory without suffering, their resistance apparently being greater."

Legge and Goadby[7] also hold that women are more susceptible to poisoning by lead than men. Legislation in Great Britain has followed these authorities, and women are barred from some of the most dangerous lead work. On the other hand, the Germans believe[8] that the apparently greater susceptibility of women to lead poisoning is to be explained not by their sex, but by the fact that they are usually more poverty-stricken than the men, are undernourished and obliged to do work for their families in addition to their factory work. Then, also, a woman's skirt and hair collect the lead dust, so that she carries it home with her after work. Observations in the pottery industry in this country[9] seemed to bear out the German theory, for while a much larger proportion of women than of men were found suffering from lead poisoning in the East Liverpool and Trenton districts, it was also found that in these districts the men are members of a strong union, are well paid, and have good living conditions, while the women are unorganized, underpaid, poorly housed, poorly fed, and subjected to the worry and strain of supporting dependents on low wages. In the unorganized pottery fields, in the tile works, and in the art potteries of the Zanesville district the men and women were in the same economic class, all making low wages, with everything which that implies, and here the rate of lead poisoning was slightly greater among the men.

Whether or not women are more susceptible to lead poisoning than men, it seems to be true that they are more likely to have the nervous form of lead poisoning than are men. Women suffer more from lead convulsions and lead blindness, men from lead paralysis and lead colic. The following are some figures that Prendergast,[10] a British physician, who practiced many years in the Staffordshire pottery district, has published. They are based on 640 cases of lead poisoning:

	Men	**Women**
Colic	77.6 per cent	69.8 per cent
Paralysis	57.0 per cent	30.0 per cent
Lead convulsions	15.0 per cent	34.9 per cent
Blindness (total)	2.3 per cent	7.7 per cent
Blindness (partial)	3.5 per cent	10.2 per cent

But the most disastrous effect that lead has upon women is the effect on the generative organs. Women who suffer from lead poisoning are more likely to be sterile or to have miscarriages and still births than are women not exposed to lead. If they bear living children these are more likely to die during the first year of life than are the children of women who have never been exposed to lead. This means that lead is a race poison, and that lead poisoning in women affects not only one generation, but two generations. Very striking proof of this fact is given by English authorities on industrial disease. Legge[11] abstracted from the reports of British factory inspectors for the year 1897 the following statistics concerning woman lead workers: Out of 77 married women, 15 never became pregnant. Of the 62 who became pregnant, 15 never bore a living child. Among all the 62 there were 212 pregnancies, but these resulted in only 61 living children; the stillbirths numbered 21, the miscarriages 90, and of the 101 children born alive, 40 died soon after birth.

Another striking report comes from the British factory inspection service. Oliver[12] gives the following figure:

	Miscarriages and stillbirths
100 mothers in housework	43.2
100 mothers in millwork, not lead	47.6
100 mothers in lead work before marriage	86.0
100 mothers in lead work after marriage	133.5

In a recent English publication[13] the case is described of a woman employed since marriage in making capsules colored with lead colors. She had been pregnant eight times, the children had all been born prematurely, and all died in the first year of life.

A French authority, Tardieu,[14] reported to the French Government, in 1905, that 608 out of 1,000 pregnancies in lead workers resulted in premature birth. In certain Hungarian villages, where pottery glazing has been a home industry for generations, children born of lead-poisoned parents are not only subject to convulsions, but, if they live, often have abnormally large, square heads, and this condition is associated with lowered mentality.[15]

It is unnecessary to emphasize the importance of these facts. Every one will admit that a poison which may destroy or cripple a woman's children is a far more dangerous poison than one which only injures the woman herself. This is why it is necessary to forbid the entrance of women into the more dangerous kinds of lead work and to surround their employment in the less dangerous ones with all possible precautions.

Lead Compounds Used in Industry, and Their Comparative Danger

Formerly it was thought that the more soluble a lead compound the more poisonous it is, but experience shows that the physical properties of a lead compound are also important. Of two compounds which are about equally soluble in human gastric juice, the dustier one is the more dangerous. English experts believe that a less soluble lead salt may be actually more dangerous than one which is more soluble, but less easily powdered. For instance, lead acetate is very soluble, but it has a disagreeable taste, so that the workman can not swallow it unawares, and it is sticky, not powdery, so that in handling it he is not exposed to dust-laden air. On the other hand, the oxides, the basic carbonate, the chromate, sulphate, and monosilicate are all dusty and some of them are very light and fluffy. They are also almost tasteless, and the workman who handles them dry breathes into his mouth and swallows quantities without noticing. The English authorities, Oliver, Goadby, and Legge, regard the lead salts as dangerous in proportion to their dustiness. They concentrate their efforts on the abolition of dust and with amazing practical success.

Probably the most poisonous lead compound used in industry is the suboxide (Pb_2O), that fine, light-gray powder given off in fumes from heated lead. This is so light that it is carried into the air by the waves of heat, and so finely divided that it is easily absorbed when breathed and swallowed. It is this oxide which causes poisoning in lead smelters, zinc smelters, brass molders, and, to a less extent, in workers with molten lead such as lead molders, lead burners, stereotypers, electrotypers, and those employed in making lead pipe and wire, sheet lead, shot, and the makers and users of solder. It is this same oxide that forms a grayish coating on solid lead, and rubs off on the hands. Men who handle solid lead sometimes get a very slow chronic form of poisoning from this oxide.

It is a question whether second place should be given to the higher oxides of lead, litharge (PbO) and red lead (Pb_3O_4 or Pb_4O_5), or to the basic carbonate, white lead. The last named is decidedly more soluble, and dose for dose it is more poisonous, but it is not so light and fluffy as red lead and litharge and it seems to be somewhat less harmful. In those American factories in which both white lead and oxides are manufactured, the rate of poisoning in 1911 was higher in the oxide than in the white-lead department and the average period of employment shorter.[16] White lead is much the best known of the lead salts, and probably is responsible for more industrial poisoning than the oxides, because it is used in great quantities in the painting trade and in the glazing of pottery, and its manufacture has always been considered one of the most dangerous lead trades; paint grinding, unless very carefully done, is also a dangerous trade. The oxides, litharge, and red lead are used very largely in making storage batteries, and they enter into the composition of rubber, glass, varnish, certain kinds of pottery glaze, the enamel used on sanitary ware, and the paint used to cover iron and steel on bridges, ships, structural-iron work, and certain parts of railway cars.

Lead sulphate is beginning to displace white lead to a certain extent in paints. It is also used in compounding rubber, and is produced in large quantities when lead ores containing sulphur are smelted. It is not nearly so soluble as the lead compounds already mentioned, but it is poisonous and has given rise to a good many cases of plumbism in American industry. Lead chromate used in paint is about as poisonous as the sulphate. The least harmful lead compound found in industry is the sulphide, which makes up the greater part of the lead ore now being mined. This was long considered quite harmless, but we know now[17] that it can be absorbed by the human stomach and set up poisoning.

How Does Lead Enter the Body?

The popular idea about lead poisoning, held especially by foremen and superintendents, is that the workman poisons himself by eating his lunch without carefully washing his hands. There is not space to give here all of the experiments that have been made to test this theory, but it is safe to say there is abundant proof that lead dust and lead fumes, not lack of personal cleanliness, are responsible for most of the industrial lead poisoning in this country, as in all countries. If a man employed in lead smelting, for instance, were to get into his mouth every bit of the soluble lead that is clinging to his hands at the end of his day's work he would not get so much lead as he breathes in during two hours' exposure to the dust and fumes in the air.[18]

It may be laid down as an absolute rule that the dustier the work the greater will be the amount of lead poisoning. In the pottery trade in the United States the writer found one case of lead poisoning for every seven women employed in lead work, while in the British potteries the proportion of cases to those employed was only 1 in 64. The American women were scraping and brushing dry white-lead glaze, and letting it fly about in the air and fall on the floor and on their clothes and hair; the English women were scraping off damp glaze, and letting it fall into troughs of water. In the smelting industry the rate of poisoning among the blast-furnace men exposed to fumes and dust was found to be 31.1 per cent, and among the men who had to clean out the flues where the dust is excessive, 62.5 per cent, while the refiners and desilverers handling pure lead but not exposed to much dust or fumes had a rate of only 14.3 per cent.

The lead dust and fumes (lead fumes consist of a very fine suspension of lead dust) do not produce their effect through the lungs, for less than one-fourth ever reaches the lungs. The rest is caught in the nose and throat, is mixed with the mucous secretions, and is swallowed.[19] Absorption through the skin may be practically ignored in considering industrial lead poisoning. In England, under the leadership of Oliver, Legge, and Goadby, all of the efforts of the Government inspectors are directed toward the prevention of dust and fumes and provision for thorough washing before meals and at the end of work. In the summer of 1910, during a visit to three white-lead factories in England, the writer observed men smeared with white lead up to their shoulders, but these men were made to wash thoroughly at noon and when they quit work. In the whole district of Newcastle-on-Tyne, where 1,320 men were employed, there were only 5 cases of lead poisoning during that year. The German regulations of the lead industries are also based on the theory that lead enters the body by way of the mouth, not the skin. In France, Gautheir[20] reported in 1901 that "while out of 1,000 white-lead workers who work with wet white lead, 50 have had lead poisoning, of 1,000 who handle it dry, or grind dry lead in oil, 105 have had lead poisoning."

Lead Industries in the United States

American industry differs a good deal from industry in other countries, and it is not safe to assume that what European writers say about the dangers of certain kinds of work is true of the same sort of work in this country. What follows relates closely to American experience, though sources of information are scanty.

It is impossible to give a list of all the occupations in the United States which involve exposure to lead in some form. Every year cases of lead poisoning from hitherto unknown sources are reported in the medical journals. Aside from the well-known lead industries, there are certain ones which are not ordinarily thought of as lead trades, yet which involve quite as much poisoning as do the more familiar ones. For instance, in the enameling of sanitary ware a very high rate of poisoning was found, sometimes even 36 per cent, a rate hardly equaled in any other industry. Lithotransfer work is recognized in Europe as a dangerous lead trade, but its danger is so little known in this country that cases of lead poisoning due to it are sometimes not recognized. Of five girls who were treated in a public hospital for supposed appendicitis (two of them even were operated on because of this mistaken diagnosis) all had been poisoned with lead from the colors they dusted on the lithotransfer paper. Many cases of brass poisoning have been reported which proved on investigation to be lead poisoning. Brass contains varying quantities of lead, and when brass is poured, the thick white fumes which rise and fill the room contain lead oxide. A few instances have been observed of brass polishers becoming poisoned with lead, because the exhaust on their wheels did not carry off the dust, and this dust contained lead.

Lead colors are known to cause poisoning in makers and handlers of artificial flowers and of wall papers. Commercial artists, whose work is retouching photographs for catalogues and advertisements, often use white lead paint, frequently in the form of very fine spray, without knowing that it is poisonous. They also have a habit of bringing their brush to a point by sucking it. Their physicians do not know that they have been exposed to lead when they complain of colic or weakness of the wrists. Fifteen cases of lead poisoning were found among members of this profession in Chicago, one of whom had died palsied after having had three abdominal operations on various wrong diagnoses.

Another source of lead poisoning, not usually recognized, is the polishing of cut glass with so-called putty powder, which is composed of 3 parts oxide of lead to 1 part oxide of tin. This powder, made into a paste, is applied to the glass, and the glass is held against a polishing wheel, so that the thin paste scatters in all directions and dries and forms a light dust. E. E. Pratt,[21] of the New York State Factory Investigating Commission, found many cases of lead poisoning from the use of lead as a hardening and tempering agent, especially in the making of magnetos. The steel magnets are hardened in a bath of molten lead, plunged into water to cool, and then rubbed with sandpaper to remove the lead. A similar process is used in the making of piano wires and springs. Pratt also found lead poisoning in linoleum and oilcloth manufacture, for litharge is used in compounding and the paints consist largely of lead colors.

The following are brief descriptions of the principal lead industries as they are carried on in the Untied States, together with statements as to which occupations are specially hazardous and should not be given to women, and which may be rendered safe enough to permit of women's employment. Only the danger from lead is discussed in what follows. No attempt is made to pass on the different occupations as far as muscular effort involved, or exposure to heat, or other harmful features are concerned. It may be that an occupation free from the danger of lead poisoning is too heavy for a woman to undertake, or that for some other reason it is not suitable for women. The statement that "a woman may do this work" means only that she may do it without much risk of lead poisoning, not that she is strong enough to do it.

Lead Mining

Probably lead mining is the least important of the lead industries so far as the employment of women is concerned, and yet it is possible that women may find employment in some such work as emptying ore cars. It is enough to say, however, that there is little danger of lead poisoning here, unless the mined ore is so handled in the course of concentrating it or transporting it as to expose the workers to a very great deal of dust. The lead ore now mined is chiefly lead sulphide, the least poisonous compound of lead found in industry, and though cases of lead poisoning have been found among miners in the Missouri lead belt[22] they are rare. Western ores still contain some oxides and sulphate and carbonate, all of them more soluble than the sulphide, and western miners are more likely to have lead poisoning.

The danger in handling lead ores can be prevented by sprinkling to keep down the dust.

Lead Smelting and Refining

Women have never been employed in lead smelting and refining and probably never will be employed in smelting; but it is not so certain that they may not be employed in refineries before long.

The dangers in a smelting or refining plant come from the fumes and dust, and in most plants every employee is more or less exposed to them, though in a clean, well-managed place there are parts which are almost free from danger. As a rule, a refinery is worse than a smelter. This should not be the case, for the smelting of ore requires a great deal more heat and produces far more fumes than does the refining of bullion and scrap. But a smelter is usually a large plant, and managed with a good deal of care, while a refinery is often insignificant in size, very neglected and dirty, and carelessly managed.

In handling the ores as they reach the smelter, dust is the danger, and this varies according to the dampness of the ore, and its composition, i.e., whether it is sulphide or mixed compounds. The ore is then either smelted at once on open hearths with great production of poisonous fumes, or it is first prepared by preroasting. In preroasting, in roasting, and in smelting there is danger from dust while the charges for the furnaces are being prepared and while the furnaces are charged, and there is great danger from fumes during roasting and smelting, and of both when the furnaces are emptied of their dusty and fuming product. In the late processes of refining the danger is chiefly from fumes. An effort is made to save the lead that passes off in the fumes by means of flues and bag houses, where the fine lead powder collects and has to be cleaned out and transported back to the furnaces. This is the most dangerous kind of work in the industry.

The occupations in a smelter which could not be held by women without great risk are: The tending and discharging of the Huntington-Heberlein pots; the tending and discharging of hand-rabbled reverberatory furnaces; the tapping of blast furnaces; work on the Scotch hearths or open hearths; and work in the flues and bag houses. Occupations which they might undertake, if conditions were made as safe as they have been in the best plants, are the following: The handling of damp ore; the feeding of blast furnaces, provided the charges are damp, the feed floor is open and clean, the charge automatically dumped, and the suction into the furnace sufficient to prevent any escape of fumes; the tending of the sinter-roasting machine (Dwight-Lloyd), provided the charge is damp, the suction exhausts strong enough to carry off the fumes, and the discharge automatic and not productive of dust. Grate cleaning for the Dwight-Lloyd machines, however, should not be given to women.

In refining there are several processes that might be undertaken by women under proper conditions, but such conditions are almost never present in American refineries. Refineries handle not only clean lead bullion, but usually great quantities of lead scrap of all kinds, dross, dirty white-lead powder, poorly roasted oxides, old storage batteries, dusty stuff of all kinds, which is bad to handle and usually fills the place with poisonous dust. This is why a refinery is often a more dangerous place to work in than a good smelter, though it need not be. If, however, great care were used to keep the place free from dust, and to carry off fumes, women might be employed in some of the processes. They should not do any of the furnace work nor handle the dross. Where the electrolytic process is used they might be employed in the battery room, though not on the dross furnaces, nor in handling the "anode mudd," the product of electrolysis. Desilverizing may be so carried on as practically to be free from dust or fumes; in fact it is probably the safest work in the whole industry, and women might be employed here. By-product and residue furnaces are not safe for women to work at, and it would be even less advisable to employ women on copper converters. On the other hand, retorting and cupeling has, in one American plant at least, been rendered free from dust and fumes. As a general thing, however, the dangers in this part of refining are fairly great, and with the exception of the plant mentioned none have been observed in which women could be properly employed. They should never be put to breaking up the cakes of litharge from the cupels.

In considering the employment of women in smelting and refining lead it must be remembered that even in the best plants accidents may occur which suddenly change a safe place into a very dangerous one. Flues fail to work and gases are driven back into the plant, the furnace gets out of order and not only do fumes escape but it is necessary to shut down and clean out the furnace, causing a great deal of dangerous dust. Even under the best management this industry can not be regarded as one in which women can be employed without risk.

Trades in Which Metallic Lead Is Used

Lead in its metallic form is not absorbed by the human body, but after only a short exposure to the air it becomes covered with a coating of gray oxide, which is soluble in the human body. Heat greatly quickens this oxidizing process, and molten lead always has a more or less thick covering of what is called dross, which gives off, when it is stirred, those delicate bluish-gray clouds that are quite visible if one watches the stirring or ladling or skimming of a lead pot. The lead poisoning that takes place in those occupations that require the handling of lead in solid or in molten form is usually slow and chronic, and often the symptoms are not very marked or typical. Very rarely, in an oversusceptible person, typical acute lead poisoning may occur.

The dangers in connection with the metallic-lead trades come from the presence of fine lead oxide in the air near the melting pots and of dust containing lead, which rises from the floor and workbenches and contaminates the air, and also from the grayish oxide which rubs off from the lead onto the hand and may reach the worker's mouth if he handles his food or chewing tobacco without washing his hands. It is almost universally believed by men in the lead industry that molten lead does not contaminate the air unless it is heated to the fuming point, and that therefore there is not need of having hoods over melting pots unless the heat in the pot is at least 800°F. To substantiate this theory a number of foreign reports could be quoted, for several lead experts in Germany and Austria have collected the air over melting pots and have failed to show the presence of lead even at a temperature of 1,000°F.[23] This is true, however, only when the molten lead is left quite undisturbed. If it is skimmed or stirred or ladled out and poured into molds, the fine coating of oxide is detached and floats up into the air on the currents of heat, and its presence can be shown by chemical tests. Experiments proving this were carried on by Dr. Earle D. Phelps, of the Hygienic Laboratory of the United States Public Health Service,[24] and he was able to prove that if lead is heated to 590°F, lead fumes are given off when the melting pot is agitated in any way. These experiments justify the rulings made by the British factory inspection service and by some State labor departments, which require that all receptacles of molten lead be covered with a hood having a suction pipe to carry off the lead in the fumes.

Dross from the lead pot is skimmed off and thrown usually on the floor, though sometimes into a receptacle, but even in the latter case a good deal of it often splashes on the floor. Here it is ground up by the feet of the workmen passing to and fro, and every draft of air lifts a little of it and blows it about, so that if dust is gathered from the surfaces where no lead has been handled this dust may be found to contain an appreciable quantity of lead. For instance, lead can be found in the dust from the tops of cabinets in printing shops, or from the surface of the magazine of a linotype machine, or from the tops of flue pipes in type foundries. Another source of lead dust is lead scrap and trimmings, which are allowed to fall on the floor, and which the workmen tread on and grind into dust. While there is probably never a large quantity of lead in the air of such workshops, it must be remembered that lead is a cumulative poison and that very minute doses repeated day after day may result in a quantity sufficient to cause quite as serious symptoms as could larger doses given at intervals.

There are so many industries in which metallic lead is used that it is impossible to give a list even approximately complete. The following are occupations in which industrial lead poisoning has been known to occur in the United States, sometimes in quite serious form:

Lead burning.

The making of solder and Babbitt.

Soldering.

The making of lead pipe, sheet, wire, machine parts, plumbers' goods.

Lead tempering of machine parts.

The making and laying of electric cables.

The making of leaden trimmings for coffins.

The making of leaden picture frames.

The polishing of diamonds embedded in a lump of lead.

The making of tin foil, which is really extremely thin sheet lead.

The using of tin foil as wrapping.

The making of car seals and can seals.

Brass founding.

Brass and nickel buffing.

Tinsmithing.

Plumber's trade. (This is increasingly a brass industry, but lead is still used and lead poisoning still occurs among plumbers. Nineteen out of 560 cases of lead poisoning in Illinois were plumbers.)

The use of solder and Babbitt is productive of much more lead poisoning than would be expected from the nature of the work. The Illinois factory inspectors' report for the year 1913–14 gives the record of 184 cases of lead poisoning from four establishments in which tin cans were soldered. In one crowded workroom, with 12 soldering machines, 100 persons were employed, and here 18 cases of lead poisoning developed during one winter month, when the windows were closed. Another industry in Illinois—the making of car seals and bearings—had a disproportionate amount of lead poisoning. There were 28 cases of lead poisoning in one year among an average force of 188 employees. Both these industries employ women chiefly, and many of these women are under 21 years of age. The percentage of cases is far beyond that reported by the notoriously dangerous lead trades in Illinois.

A few instances may be given of serious lead poisoning in occupations that are not usually considered by employers as involving any particular danger, but in which metallic lead is used. For instance, a man was treated in a Chicago hospital for lead poisoning who had for two months been employed in sweeping up the shavings from casting and finishing machines in a factory making lead fixtures. Another man sickened after four weeks' work. He had been gathering up and wheeling away dross from melting pots. In a Philadelphia hospital a man was treated for acute lead poisoning who had worked for only three weeks, making lead stoppers and perforated filters for washbasins. Again, in the same Chicago hospital, there were treated for lead poisoning a man who had handled lead, copper, and brass junk in a refinery; another who had lifted pig lead in a shipping room; a lead filer; a brass filer; and a lather and shingler who had the habit of holding lead-covered nails in his mouth.

Lead burning is a notoriously dangerous trade. Skilled lead burners almost never escape the effect of the lead fumes given off when they apply a hot flame to melt together the seams of the lead lining in tanks or other receptacles. The lead burner is obliged to hold his head close to his work and to climb into the tank he is lining, or to put his head into the receptacle if it is too small for him to enter. This is the work generally understood when the term lead burning is used, namely, making lead linings for receptacles which are to contain corrosive substances. But there are other forms of lead burning that do not require so much skill and are not nearly so dangerous. The burning of lead connectors in storage-battery manufacture is a typical example. Here the worker uses a tiny flame and lets it play over the pure lead that is used to connect the battery plates. A certain amount of lead fume is given off in the course of this work,[25] but the amount is not large and, with abundant ventilation, it can be diluted to a point of safety for all but those very susceptible to lead.

The Printing Trades

Probably the most important of the industries using metallic lead is the printing industry, including the allied branches of linotype casting, monotype casting, stereotyping, electrotyping, and ordinary type founding. In all countries the printers' trade has long been considered as productive of more illness than would be expected in an industry in which wages are high; hours usually not long, and in which there is no great contamination of the air, nor exposure to excessive heat or cold, nor excessive muscular effort.

The unhealthful features of the industry are the following: It is an indoor occupation, often carried on in vitiated air; it does not require much physical exertion, and in consequence the printer's circulation is likely to be sluggish, and he is oversensitive to cold; the nervous strain is great; the printer exposed to various poisonous substances, the most important of which is lead. How important lead is as a factor in the ill health of printers can not be stated with any positiveness. Yet the evidence gathered from all civilized countries and extending over a number of years tends to show that it is important as a cause of sickness. An examination of 200 working printers in Boston and Chicago showed that 18, or 9 per cent, were suffering from chronic lead poisoning; 107 of the 200 had symptoms of ill health.

Lead poisoning may be acquired by printers if they handle food or tobacco with hands which have become smeared with lead, or if they breathe lead dust and fumes. The sources of lead dust are: In the composing room, the dust from the type cases; in the linotype room, the scraps of lead from the machine which fall on the floor and are ground up by the feet of passers-by, and the dust from cleaning the linotype machines and plungers; in stereotyping and electrotyping, the scraps from trimmers, routers, and saws, and the dross from the kettles. In addition, most shops melt and recast their old type and scrap, and this is another source of lead dust.

The sources of lead fumes are: All pots of molten metal, if the metal is agitated by stirring or by skimming off dross, or by ladling and pouring. In stereotyping, electrotyping, and remelting and casting type there is enough agitation of the molten lead to cause lead contamination of the surrounding air, but in linotype and monotype work the metal in the pot is hardly disturbed at all, and repeated tests made of the air over these machines shows that lead fumes are not given off.[26] This does not mean that linotypists may not suffer from a slowly developing chronic lead poisoning. But this is a result of lead dust, or of fumes coming from pots in the linotype room where scrap is melted. If the linotype composing room were kept clean and no work were carried on there except hand composition and machine composition, there would be no risk of lead poisoning except from the cleaning of machines and plungers.

Linotype casting.—Linotypists insist that unless the fumes from the pots are carried off they suffer from symptoms of ill health, and that in shops where exhausts have been installed the failure of the air current to work for a single day will be enough to bring on headache, lassitude, dullness, and inability to work at the usual speed; but the fumes of lead in as small quantities as those given off from molten lead never produce symptoms quickly, their effect being very slow and subtle. What the linotypist complains of is really the contamination of the air by carbon monoxide from the naked gas burners under the melting pots, and there should always be a fume pipe with an exhaust over such a burner. It is probably unnecessary to install exhausts over type-metal pots in which the melting is done by electric current.

Hand composition.—In the composing room there should be very little risk of lead poisoning. The danger in the work of the typesetter should be limited to the handling of lead type. That risk is inherent in the trade, and can not be done away with. If it were the only risk, it would be possible to protect the compositor fully from all danger of slow chronic lead absorption simply by providing him with ample washing facilities. Then, if he did get lead poisoning, it could be assumed that he was eating his lunch or handling his chewing tobacco without washing his hands. But the case is in actual practice not nearly so simple as that. A typesetter may be a man of scrupulously clean habits, and yet he may get lead poisoning because there is lead dust in the room where he works, or because he has to blow the dust out of old type cases, or work near a melting pot or near a pile of lead skimmings blown about by drafts of air.

Monotype casting.—Like linotype casting, monotype casting does not result in lead fumes except when the dross is skimmed off, but gas is almost always used for heating and all that has just been said in the section on linotype work about the evils of gas fumes and the need of carrying them away applies to monotype casting machines. Monotype machines drop lead scrap continually on the floor, but as a ususal thing casting is carried on in a separate room, and the lead scrap is not scattered beyond this room. As a rule, also, the monotype casting room is well placed and well ventilated. Indeed this department seems to be planned and managed better than any other in job printing and newspaper work.

Stereotyping.—The reverse is the rule in stereotyping, for this department is likely to be the worst housed and the worst tended of any in the printing shop. The evils in stereotyping are the very disagreeable and indeed harmful fumes given off when old plates are being melted down or "burned off," fumes which come from the ink and contain acroelin, an irritating poison; the lead oxide which experiments have shown to be given off at the temperature often used in stereotyping; the dust caused by trimming and routing the plates; and the heat from the kettles. All these evils are avoidable, and all have been avoided to a large extent in a few model plants. This has been done by placing hoods with strong exhausts so that they will carry off not only the disagreeable fumes at the beginning of the process, but the more dangerous though less noticeable lead fumes that come off later on, or by placing a powerful fan in an outer wall of the room. Dust is prevented by careful gathering up of the scrap and trimmings, and by throwing dross into a receptacle instead of on the floor.

Electrotyping.—The important features in this work are the pot in which the lead is heated for the backing of plates, the hot pans on which the molten lead is poured, the trimming and routing of the plates, and the sawing and beveling. As in other departments in a printing shop, old plates have to be remelted and the metal used again. When these ink-covered plates are melted down, the same sort of gases are given off as in melting stereotype plates. The lead in the melting pots in an electrotype foundry is often allowed to run up to a higher temperature than is necessary, because it is easy to cool it down to just the right temperature in the backing pans. Experiments show that lead fumes are given off at these higher temperatures when the lead is agitated, and, therefore, to make electrotyping safe some method for carrying off these fumes is necessary. An electrotype foundry can be made free from lead fumes, and the lead scrap can be so carefully handled that lead dust will be but a slight danger. In the majority of electrotype foundries little or no attention is given to carrying off the poisonous fumes. A disagreeable feature of the work is the use of black lead, which is very light and flies about, darkening walls and ceilings and settling on the windows. Other disagreeable features are the heat, and the blast of steam that in some places is used to clean plates.

There is an increasing tendency, now that the price of lead has risen so high, for newspaper plants and large job houses to refine the dross skimmed off the melting pots instead of selling it to junk dealers. Sometimes they simply remelt it, recover a small part of the lead, and sell the rest, but in some plants a cupeling furnace is installed and the dross is actually smelted. This is work attended with all the dangers described under lead smelting, and it should be safeguarded by the methods described there. It should always be done quite apart from any other work.

Women in the Printing Trades

Women found their way long ago into the printing trades, though not into monotype casting, stereotyping, or electrotyping, nor are they as yet employed in large numbers in any branch of actual printing. They are accepted as members of the typographical union on exactly the same terms as men, and must go through the same apprenticeship, and, after becoming journeymen, they have the same hours and receive the same pay as men. They are found in large numbers as proof readers, and are usually the operators on the monotype keyboards, but do not work in the monotype casting room. In nonunion shops they are press feeders, sometimes doing all of that work. As compositors and linotypists they are not numerous. In the course of an investigation made in 1916 of the printing industry in seven American cities, only 14 woman linotypists were found out of a total of about 1,532 operators, and only 103 hand compositors out of a total of about 3,800.

As is true of so many of the skilled trades, a wide difference of opinion exists concerning the entrance of women into the printing trades. This difference was brought out clearly at the meeting of the International Association for Labor Legislation in Lugano, in 1910, and at the following meeting in Zurich, in 1912. The Italian delegates took the stand that, for the good of the race, women must not be allowed to work in this industry, since the danger of lead poisoning is too great; they admitted, however, that they had no evidence of an undue amount of lead poisoning among the few women employed in Italy. The Austrians also were in favor of forbidding women to work at any occupation in printing in which contact with lead is involved, and the regulations now in force in Austria contain this provision. The British delegates, on the other hand, maintained that it was entirely possible to do away with the danger of lead poisoning in the printing trade, and that efforts should be directed toward making the industry healthful for both men and women, rather than toward shutting women out from occupations in which they had long been employed, and which were in many ways suited to their powers. The French and American delegates stood with the British.

The typographical industry is not the only one in which efforts have been made to prohibit the entrance of women on very insufficient grounds. The danger to health in this industry is avoidable, and the logical thing to do is to institute such sanitary measures in printing shops as will make them safe for both sexes. The Austrian statistics of lead poisoning in woman printers, on which so much stress has been laid, depend on the fact that Austrian women used to be employed in the type foundries, finishing type by hand, and this work is dangerous for men as well as women, and should be replaced by machinery. Machine composition, hand composition, monotype casting, and electrotyping can be carried on, and in the best shops are carried on, in such a way as to reduce the danger of lead poisoning to a minimum. In stereotyping this would be more difficult, but the greater physical strength needed by the stereotyper makes it highly improbable that this occupation will ever be given to women.

Type Founding

Type founding is closely connected with the printing trade, and indeed a few newspaper offices have their own type-founding machines in addition to the monotype and linotype machines. As a usual thing, however, type founding is a separate business in the United States, though in Europe it is often carried on in connection with printing.

Statistics of lead poisoning in the printing trades in Europe always show a high percentage among women employed in type founding. In Austria the woman foundry helpers have much the highest rate of lead poisoning in the whole industry, 1 case out of 9 women employed, while the compositors have only 1 out of 35 employed. In Germany five times as many founders as compositors have lead poisoning. In this country the only cases reported of lead poisoning among women engaged in the printing and allied trades have been among type-foundry employees. The danger of work in a type foundry is very much like that in stereotyping, except that there is far more fine lead dust. The heat in the casters often runs up to the point at which lead oxide is given off, and it is not customary to place hoods over the molten lead. The evil of gas fumes is the same as that described under linotype work. But the worst feature in the type foundry is the lead dust from the hand finishing of type. The type cast by the older kind of machine, the Bruce machine, has to go through various processes of filing, "dressing," or grooving, and "kerning," or smoothing, and inspecting, assorting, and packing. This is fine work and all of it is productive of dust. The woman finishers sit bent over their benches, with their heads close to their machines or tools. They use pads of plush to hold the type, and these get full of lead dust and are shaken and beaten clean from time to time, and the fine gray powder that collects on the benches is brushed off. This finishing work is often carried on in the same room with the casting machines, with their gas fumes and possibly lead fumes.

So long as casting machines of the old pattern are used and hand finishing has to be done, type founding will be the worst branch of the printing trade. The newer make of caster, known as the Barth machine, casts type which is already finished, and needs no further handling.

Summary of the Metallic-Lead Industries

To sum up the features which are common to all the trades in which lead in metallic form is used: The form of poisoning found in these occupations is slow and insidious and sometimes shows itself only in an increased tuberculous rate, because the resistance of the body to infection has been lowered by mild chronic lead poisoning. The dangerous feature is lead oxide in the form of fine dust, which rises from the surface of molten lead and is rubbed off from the surface of solid lead. It is perfectly possible to prevent all, or almost all, air contamination by this oxide dust. When it can not be entirely prevented the proportion in the air can be reduced to the margin of safety for all but the oversusceptible by ample ventilation. The employment of women in these industries can be permitted, because there is no reason why the risk of lead poisoning in working with lead metal should not be reduced to a minimum.

Manufacture of White Lead

This is probably the most notoriously dangerous of the lead industries, the one that has attracted more attention than any other, in European countries and that has led to special legislation for the protection of men and women engaged in it. It can not be assumed that the description of the white-lead industry in Great Britain or France or Germany applies to conditions in America, because our methods of manufacture differ in several important respects from theirs. On the one hand, we use a dry method where they use water, and this means more danger from dust in our plants; but on the other hand, we have developed machinery to a far higher point than they have, thus doing away with hand work and reducing the number of employees required.

Old Dutch process.—The Old Dutch process is still the one most commonly used in the United States. The lead is cast in thin disks or "buckles." Women may properly work at casting provided only clean lead is used, not scrap with white-lead dust clinging to it, and provided the precautions described in the last section are observed. These buckles are packed in pots with acetic acid and stacked in layers in old tan bark where they are left for about 100 days to "corrode" or change from the metallic form into the basic carbonate, white lead. This work is known as "stack setting" or "setting the blue beds," and the English law allows women to do it. So long as only clean blue buckles are used for the blue beds there seems no reason why women should not do the work. Unfortunately in some of our plants it is the custom to mix with this blue lead parts of buckles which have been imperfectly corroded and which are more or less covered with white lead. When this is done, the character of the work is quite different, for the stack setters then are handling not only clean metallic lead, but white lead, which is often dusty. Women should not be allowed to work in the blue beds when old buckles are used.

When corrosion is complete the tan bark has to be taken off, and the pots lifted and emptied. In England and Germany the white lead must be sprinkled with water before emptying to keep down the dust, yet even so the English law forbids the employment of women in "stack stripping" or "stripping the white beds," as this work is called. In our factories we can not sprinkle the white lead, because the corroded buckles must go through a series of grinders and screens to separate the white lead from the unchanged metal in the center of the buckle, and dampness would result in clogging the screens. Great improvements have been made of late years to do away with the dust in American stack stripping, but in spite of that the work is dangerous, and does not admit of the employment of women.

Dry-pan room.—The second danger point in white-lead manufacture is the dry-pan room, where the white lead, after repeated washings, is pumped into great hot pans, and left to dry for many hours, then conveyed by various methods to the barrel packing machines, or to the place where it is to be ground in oil. In some factories the white lead, still suspended in water, is ground as "pulp lead," the oil displacing the water gradually and no drying process being needed. Work in the dry-pan rooms has been very much improved of late years in the best factories. Where formerly the dry white lead was shoveled out and dropped into trucks, it is now drawn to the edge of the pan by a long-handled hoe, and falls into a conveyer which carries it to the barrel packer or to the place where it is to be mixed with oil. Both pans and conveyers are covered except for a small opening during the time that emptying takes place, and under this cover is an exhaust which prevents the dust from escaping.

In spite of these improvements, however, nobody would advise the employment of women in the dry-pan room of a white-lead factory, nor in the two following processes: Packing the dry white lead, which, no matter how carefully done, is inevitably dusty work, and grinding white lead in oil. The department in which they may be employed, provided conditions are as they should be, is the final filling of small kegs or pails with lead and oil. If women are to be allowed to do this, however, the work must not be carried on in the same room with the grinding of dry lead, nor with barrel packing, nor must any other source of white-lead dust be permitted there. The record was obtained of a young girl who contracted lead poisoning doing this very work, and it was assumed that she had absorbed the lead paint through her hands. But when closer inquiry was made it was discovered that she was working near the door of the grinding room, and she said that very often clouds of white dust would come blowing in through that door. Her poisoning is attributed to the inhaling of dust, not to the absorption through the skin.

Carter process.—Another process for corroding lead is gaining ground in the United States. This is the so-called Carter process, based on the same principle as the Old Dutch process, but bringing about corrosion in two weeks' time, while the Old Dutch process takes about 100 days. This rapid corrosion is effected by atomizing melted lead in a blast of superheated steam, and subjecting this fine lead powder to the action of acetic acid in large revolving cylinders. Streams of carbon dioxide are driven into the cylinder, and a spray of acetic acid is introduced from time to time. The first corroding period lasts five or six days and the lead is then in little balls of carbonate with uncorroded particles in the center. This must now be ground and corroded again. The final corrosion over, the white lead is ground in water.

The advantage of the Carter process is that, being largely mechanical, it reduces the number of employees who must be exposed to poisoning during the process; and from year to year mechanical improvements make actual contact with the lead less and less necessary. The disadvantages are that the lead is in the form of powder from the very beginning, and that there are certain points in the process where it is hard to avoid dust, even when everything goes well, and where it is impossible to do so if anything goes wrong with the machinery. It would not be advisable to employ women in connection with the atomized blue lead, nor the cylinder room, nor on the thrashers. In fact, the only place in which they should be employed is in packing lead in oil, provided the precautions given above are observed.

Grinding of Paint

The only risk in this work is in handling the lead compounds—white lead, lead chromate, or chrome yellow, and red lead—or in breathing air contaminated with these compounds. In a well-managed paint factory, weighing of lead colors is done in such a way as to make the escape of dust impossible, and grinding in oil takes place in covered chasers. These processes are carried on in rooms separate from that in which the keg filling is done. Under such circumstances there is no reason why women should not work at keg filling. It is very important to separate the dusty work from the safe work. In a Chicago paint house a girl engaged in pasting labels on her paint cans contracted lead poisoning because they had put her to work so near the open scales where the white lead was weighed as to expose her to the dust from the dry white lead.

Painting Trade

It is so very improbable that women will ever engage in house painting or ship painting that these two branches of the painting industry need not be dwelt on. But there seems no reason why, so far as their strength is concerned, they should not be employed in much of the painting that is carried on in factories, especially in painting furniture, picture frames, moldings, etc. They may also undertake the painting of wheels for wagons and carriages. This sort of painting has, up to now, been done very largely by unorganized and more or less unskilled painters, and the substitution of machinery for hand work has increased very greatly in recent years. Much of the painting of carriages, wagons, automobiles, and agricultural implements is done by mechanical dipping into tanks of paint, and painting by hand is sometimes limited to the decorations on the last coat. A great deal of leadless paint also is used for these articles. The painting of furniture, picture frames, moldings, and other small objects is of very little importance from our point of view, because leadless paints are used almost entirely.[27]

The danger in the branches of painting in which women are likely to be employed lies in the process of sandpapering dry paint which contains lead. Even when the actual painting is done by machinery the paint, after drying, is often rubbed with sandpaper to prepare it for the next coat. This is especially true in painting wheels. Carriage and wagon wheels are sometimes given several coats of paint rich in white lead or red lead, and each coat except the last is rubbed with sandpaper and the dust is brushed off with a soft brush. The body of the vehicle, though painted chiefly with leadless paint, may be given first a coat of white-lead paint and white-lead putty to fill in the inequalities of the wood, and these are rubbed with sandpaper.

Not only white lead, but red lead and a lead oxide known as orange mineral, and yellow lead chromate, and the mixture of chromate and Prussian blue called chrome green, are used in paints. Finally, lead sulphate, sometimes called sublimed white lead, has come into increasing use of late years as a substitute for white lead. The most soluble, and consequently the most poisonous of these forms of lead, is white lead. Next come the oxides, and work with oxide paint may be more dangerous than with white-lead paint, because red-lead paint does not keep well and is usually mixed fresh each day by the painter. The chromates and lead sulphate are less soluble, but quite poisonous enough to require all possible precautions in handling.

The most important of these precautions is the avoidance of dust from dry sandpapering. In Germany, France, Belgium, and Austria the law forbids dry rubbing of lead paint. If it is to be sandpapered, the sandpaper must first be moistened in some mineral oil to prevent the dust; but rubbing with pumice stone and water is much more usual in those countries, except for the first coat of paint, where water can not be used, for it would raise the grain of the wood and cause metal to rust. Other sources of dust in connection with painting are the chipping off of old paint that contains lead, the wearing of dirty working clothes, and the shaking out of drop cloths that are full of lead paint. It is absolutely necessary for painters to have good washing facilities for their use at noon and on quitting work, because paint clings to the hands and can easily contaminate the food unless it is carefully washed off before the lunch pail is opened.

In employing women in any branch of the painting trade it will be necessary to prohibit dry rubbing down of lead paint, mixing dry lead compounds with paint, using dirty drop cloths, and chipping off old lead paint. It will also be necessary to insist on the provision of hot water, nailbrushes, and towels for their use.

Commercial Artists or Retouchers

This highly skilled branch of painting, which gives employment to many women, has already been mentioned. It is enough to say here that every effort should be made to substitute zinc white for white lead in the work of retouching, and that where white-lead paint is used it should not be used in an air brush. The artists should know, as they often do not, that they are using white-lead paint, and they should be warned never to put the paint brush into the mouth. Several instances have occurred of men and women who, severely poisoned with lead, have assured their physicians that they were using only zinc white, and in consequence the source of their symptoms was not discovered and they were allowed to keep on with their work until seriously poisoned.

Lithotransfer Work, or Decalcomania

This consists in preparing transfer paper which is used in impressing patterns on pottery. The colors used are largely lead colors, and they are ground dry and dusted dry onto prepared paper. When the work is done by hand even at a table provided with a glass screen and an exhaust there is decided danger of poisoning from the fine, light dust. Fortunately, machine dusting of colors has been introduced of late, and this has lessened the dust, though it does not entirely prevent the escape of dust. Lithotransfer work is regarded in Europe as one of the most dangerous lead trades. No recent information is available concerning the industry in this country. In 1910 eight girls and one man were found in Chicago who had suffered from acute lead poisoning during employment in one large lithotransfer factory.

Manufacture of Red Lead and Litharge, or "Roasting Oxides"

In the United States the roasting of oxides is not carried on in connection with lead smelting, as it is in most other countries, except for one smelting plant. It is either done separately or in connection with the making of white lead. The dangers in the work consist in the fumes from the furnaces, and in the dust from dumping, grinding, screening, and packing the oxides. There is no lead industry in the country which shows such a variety of conditions as does the roasting of oxides. There are grinding rooms so free from dust that one would never know red lead was manufactured there, while there are others covered with scarlet powder from ceiling to floor. There are also furnace rooms practically free from fumes, with mechanical rabblers, with hoods over the feed doors, and with mechanical discharging under cover, and again there are furnace rooms with no devices for carrying off the fumes that escape when the furnace man opens the door and works the charge back and forth or rakes the oxides out into an open truck.

The charge for the furnace is not always pig lead; much of it may be dry scrap, dross, refuse from white-lead works, and imperfectly roasted oxides, and this dusty stuff lies in heaps on the floor of the furnace room. An almost invariable source of dust is the dump into which trucks of oxide from the furnaces are emptied, to be ground and screened, and another is the dump from the screening and bolting machines. In rare cases grinding takes place in water, but this has the disadvantage of necessitating the use of drying pans like those described in the section on white lead (p. 28), the emptying of which is always dusty and dangerous.

Lead oxides are very light and fluffy, and it is hard to prevent dust in dry grinding and bolting and packing. Even where mechanical barrel packers are used the work is dusty, and packing small kegs by hand is very unsafe work. In an intensive study of the white and red lead industries, in 1911, there was found a great deal of lead poisoning in connection with white-lead work, for the safety devices now found in that industry had not yet been introduced.[28] There was, however, an even higher rate among the workers in red lead, and the manufacture of red lead and litharge has not undergone as much improvement in the years that have elapsed since then as has the manufacture of white lead. It does not seem safe to recommend the employment of women in any department of the manufacture of lead oxides.

Manufacture of Storage Batteries

This is the trade in which lead oxides are used in great quantities, and in which women have already entered and will probably enter in very considerable numbers in the near future. It is regarded in European countries as one of the most dangerous of the lead trades, and strict regulations are in force both as to the sanitation of the places in which the work is done and as to the methods of work permitted in them. It is only rather recently that we in America have awakened to the knowledge of the danger involved in this work. In 1913 it was found that in five storage battery factories, at least 17.9 men in every hundred employed in work exposing them to lead had suffered from lead poisoning, and this figure was far below the truth, because it was impossible to get anything but very scanty information from three of these factories.[29] In one factory where records have been kept, the rate in a single department was as high as 40 per cent. This department has been made much safer in the five years since the study was made. The type of lead poisoning found is usually acute, with colic, and in severe instances lead convulsions, but not palsy except sometimes a slight form. This is explained by the fact that the employees are a shifting force. They seldom remain long in this kind of work and if they become poisoned it is because they have been exposed to large quantities of soluble lead, which is quickly absorbed and causes acute symptoms.

The work in a storage-battery factory is fairly complicated, but for the purpose of this study the processes may be divided into three classes: Those which have to do with acids or paint, not lead; those in which metallic lead only is handled; and those in which lead oxides, litharge, and red lead are handled. The first class may be ignored, for there is not lead danger involved so long as these processes—forming and charging and painting—are carried on, as they usually are, in rooms separate from the lead rooms. The second class includes casting or molding the lead grids for the Faure plates, trimming them of superfluous lead, casting and "spinning" the Planteé plates, and lead burning the final connections on the receptacle. This last is a soldering process in which pure lead is used instead of ordinary solder, and the heat is applied by means of an air-hydrogen, or oxy-hydrogen flame. The third class covers the mixing of oxides with various liquids to form a paste, the rubbing of this paste into the lead grid to make a Faure plate, and the inspection, cleaning, assembling, and lead burning of these pasted plates.

By far the most dangerous work is mixing the paste and applying it to the plates. There is no need of describing these processes fully, because the employment of women in such work should never be allowed. However, exposure to lead-oxide dust is not confined to these two departments. The pasted plates are dried, and though the surface after drying is hard and firm, yet the plates can not be handled without raising dust, the shelves on which they rest are always covered with dust, and the work of lifting them from the racks and carrying them to the assembling room is dusty. The work in the assembling room involves handling these pasted plates in various ways.

The two departments in which women are likely to be employed, and, indeed, are already employed, are the molding and casting of grids and the assembling of formed plates. In the molding room there is only metallic lead, and the dangers here can be dealt with fairly easily. Melting pots must be properly hooded; molding should, if possible, be mechanical, not hand work; the lead scrap from saws and trimmers should be caught in receptacles, not allowed to fall on the floor, and dross from the melting pots should be handled in the same way. The room should be large and amply ventilated, especially if gas is used under the kettles. In short, the employer should act on the principle that melting and molding lead, no matter how well done, results in some contamination of the air, and the only safe thing is to dilute this contaminating lead to the greatest possible extent with quantities of fresh air.

In the assembling room it is not so easy to do away with the danger of lead poisoning, because here is found not only metallic lead but more or less dry lead oxides from the pasted plates. These plates are inspected and the imperfect ones are rejected, or straightened, trimmed, and filed. Small plates, which have been pasted in pairs, are sawed apart. The edges and the projecting piece of the grid called the "lug" are cleaned to get rid of the paste and leave a shining metallic surface, so that good connections may be made by the lead burner. This work may be done by hand or by machine. The actual assemblers also handle these dry oxide plates, but not in such a way as to involve much dust. They group the plates together and slip a thin wood or rubber separator between each pair of plates. Then these groups are fastened together by the lead burners.

In 1913, in two factories employing 620 men in lead work, the proportion of cases of lead poisoning in these different classes of work was as follows:[30]

Casting—metallic lead only	1.7
Mixing paste—dry lead oxides[31]	40.0
Pasting plates—lead oxides, dry and wet	19.4
Assembling and lead burning	10.7

This shows how much greater is the risk in assembling and lead burning than in casting, the added element of risk being the presence of lead-oxide dust. If women are to be employed in the assembling and lead-burning department great precautions will have to be taken. The space allotted to each worker must be much more generously calculated than in an ordinary factory. Not only must there be no overcrowding, but there must be a very ample supply of air. No oxide dust must be allowed to accumulate on floors or benches, and no dry cleaning must be allowed. Benches must be wiped off with moist cloths and the floors mopped or flushed. Racks of dry plates must never be stored in this room, nor the drying cabinets be placed in this room. After the dried plates have been removed from a rack this rack must be wiped with a wet cloth before it is used again. Lug cleaning must be done by machine and the dust carried off by suction. It is far better to separate the actual processes of assembling from the work of inspection, trimming, sawing, and lug cleaning. If this is done, assembling and lead burning will probably prove to be as free from danger as the work in the molding room.

Glazing of Pottery and Tiles

The pottery industry of the United States has never, up to now, given employment to large numbers of women in those occupations where lead poisoning is a danger. In 1910 and 1911 the white-ware industry, which was carried on chiefly in the region around East Liverpool, Ohio, and in and about Trenton, N.J., had 393 women engaged in lead work in 68 potteries, while 2,112 men were working in these same processes.[32] At that time lead poisoning in the potteries, so notorious in England and Germany, had attracted no attention at all in this country, perhaps because the industry was not large and was concentrated in two regions. Many improvements have taken place in American potteries since that date, especially in white-ware potteries where the labor is strongly organized. The so-called yellow ware, and art and utility ware, is made in the Zanesville, Ohio, district chiefly, and the labor is entirely unorganized. Tile factories are much more scattered, being found in many States. Here, too, the labor is unorganized.

The glaze used in the white-ware potteries which were visited contained from 1.75 to 33.3 per cent of white lead. In the potteries making art and utility ware (yellow ware) and in the tile factories the glazes contain from 5 to 60 per cent of white lead. The dangerous processes are mixing the glaze, dipping ware into glaze, cleaning the dipped ware to get rid of the excess of glaze and stacking it on boards or trays to be fired, and decorating it by the processes known as color blowing, or tinting, and ground laying.

Mixing is done by unskilled laborers under the direction of a skilled foreman. The mixed glaze is poured into tubs for the dipper, who is a highly skilled workman. He immerses the ware in the glaze, brings it out in such a way that the coat of glaze is evenly distributed all over the surface, and puts it on a board or tray to dry. This work is not done by women in the United States except sometimes in art-ware potteries when the vase is both dipped and brushed with glaze. The dippers' helpers, however, are women, except in sanitary-ware potteries, where the large and heavy ware could not be lifted by women. The women do what is called finishing, that is, they remove the excess of glaze either by sponging or by rubbing it with a dry, rough fabric, or by scraping with a knife, and blowing or brushing away the dust. These women also stack the ware on boards for the glost-kiln men, they clean the boards on which the dipped ware is carried, sometimes by sponging, but sometimes by pounding against the floor or wall to shake the dust off, and they sweep up the glaze room. The rate of lead poisoning among these women employed in the potteries in 1911 was just below 20 per cent, while among the men dippers it was only 6.5

per cent. In the art and utility ware potteries this difference between the two sexes did not appear. The rate there was a little over 20 per cent for both sexes. The workers in the latter industry are exposed to greater dangers than those in white ware, because the glaze is richer in lead, more decorating is done with lead colors, and a lower standard of living, due to wages being decidedly lower than in the white-ware potteries, makes them more susceptible.

The glazing of tiles is sometimes fairly safe work, sometimes very bad. For white tiles the glaze may contain as little as 5 per cent of lead, and it may be applied by machinery. But colored glaze may contain 50 or even 60 per cent of lead, and dipping is done by hand. "Fettling," that is, scraping off the excess of glaze, is more dangerous than the actual glazing of the tiles because it is dustier. In all English tile works and in many German ones it is the rule to scrape the excess glaze while it is damp and let it fall into a pan of water. In all the tile works visited in this country much of the fettling, if not all, is done after the glaze is dry, and the glaze dust is allowed to fall anywhere.

Color blowing, or "tinting," has given way largely to decalcomania—decorating by means of lithotransfer paper. Though the making of lithotransfers is dangerous work, their application to pottery ware is perfectly safe. In tinting, the colors are applied in the form of a spray driven through an atomizer by compressed air. The ware is held under a hood, and an exhaust is supposed to carry off all the spray that does not fall on the surface of the ware. Ground laying consists in dusting dry colors on a prepared surface by means of pads of cotton. Both kinds of work involve a good deal of risk unless great precautions are taken.

A visit to an English pottery or tile works will convince anyone that it is possible so to construct dipping rooms as to allow of thorough flushing down, and to carry on dipping in such a way that the room is kept clean, and finishing in such a way that the women who scrape the glaze from ware and tiles run very little risk of lead poisoning. In English potteries in 1910 the rate of plumbism was 0.8 per cent for men and 1.5 per cent for women, while in 68 American potteries and tile works in 1911 the rate was 8 per cent for men and 14 per cent for women—almost exactly ten times as much. The difference between the two countries at that time was very striking, but conditions in American potteries have improved since then and the contrast is not so great now.[33]

Manufacture of Porcelain Enameled Sanitary Ware

This is a very dangerous lead trade, in which women have never been employed and probably never will be, for the work requires a good deal of physical strength. The processes involving exposure to lead are grinding the enamel, which contains varying proportions of soluble lead, and sifting it thickly over red-hot ironware, in the course of which great clouds of dust are given off. The work is done on piecework basis; the firing of the ware is heavy work and very hot, both the heat and the great exertion increasing the susceptibility of the enamellers to lead poisoning. The rate of poisoning among 1,012 men employed during 1911 was 21.4 per cent, but 148 men who were examined carefully showed a rate of 36 per cent.

Compounding of Rubber

The compounding of rubber is the only process in the rubber industry that involves exposure to lead. Litharge (lead oxide), lead sulphate (commonly called sublimed lead), and in rare instances white lead are sifted or bolted, weighed, and mixed in mixing mills with the crude rubber. The risk here is from lead dust, and it can be minimized by careful handling, scrupulous cleanliness of the premises, and the use of exhausts at the scales and mixing mills. This work has never yet been done by women and it is not advisable that they should be employed in it.

Prevention of Lead Poisoning

It is not hard to remember the rules for protecting workers against lead poisoning, if one bears in mind the fact that lead enters the human body chiefly through the mouth, either in the form of dust and fumes or smeared on the surface of food and tobacco. All the rules formulated for the lead trades by sanitary experts are based on the prevention of lead dust and fumes and the necessity for bodily cleanliness on the part of the workers. Briefly stated, the following rules should be enforced in every lead industry where women are to be employed:

Scrupulous cleanliness of floors, walls, workbenches, window sills, tops of pipes, and all other surfaces where dust might collect. Cleaning should be done wherever possible with water or oil. Dry cleaning should be forbidden during working hours.

Ventilation should be more ample than that required for work that is free from lead.

All dusty work should be carried on under cover, or with an exhaust so placed as to catch the dust at its point of origin.

All receptacles for molten lead should be hooded, and the hood connected with an air exhaust; dross skimmings should be thrown into a receptacle.

Lead/scrap and trimmings should be caught in receptacles, not allowed to fly over the floor.

No dry rubbing of lead paint and no scraping or brushing of dry lead glaze should be allowed.

A full suit of working clothes of washable material should be worn by every woman engaged in lead work. This suit should be laundered at least once a week. If there is any exposure to lead dust a washable cap should be worn and laundered at least once a week. So far as the work permits, gloves, preferably washable, should be worn and should be washed at frequent intervals.

No food should be taken into a workroom; no worker should eat lunch without first washing her hands thoroughly with soap and hot water and the use of a nailbrush. Women should be advised to rinse the mouth or brush the teeth before eating lunch.

A physician should be employed to supervise the woman lead employees. He should examine on employment, or shortly after employment, every woman who is to engage in lead work, and should reject those who are anemic or show evidence of disease of lungs, heart, or kidneys, or who are pregnant. It is advisable to reject also women suffering from obstinate constipation, women with very defective teeth, and married women who are in the childbearing period. The physician should reexamine women engaged in lead work at frequent intervals. It is better to make a cursory examination once a week than a more thorough one once in two months.

In deciding as to the length of the workday for woman lead workers it must be remembered that the longer the hours the greater the dose of lead absorbed, and the shorter the period for elimination of the dose before the next workday. It must also be remembered that fatigue increases susceptibility to lead poisoning, and so does a heated or humid atmosphere.

Source

Hamilton, Alice. "Women in the Lead Industries." U.S. Department of Labor, Bureau of Labor Statistics. *Bulletin No. 253.* Washington, DC: GPO, February 1919.

CHAPTER 24

ABEL WOLMAN
(1892–1989)

Be praised, My Lord, through Sister Water; she is very useful, and humble, and precious, and pure.

—Francis of Assisi, *Canticle of the Sun*, c. 1225

Many public health professionals would be pleased to have a career with some impact on the public's health; ideally, their impact would be high. During his lifetime, Abel Wolman enjoyed three such careers, each about a quarter century in duration and each of high impact. The first was spent as a sanitary engineer for the state of Maryland. The selected reading, on the chlorination of municipal water supply systems, is drawn from this period. Wolman's second career was spent as a teacher, training the next generation of public health leaders. Following his retirement from the faculty at the Johns Hopkins University, Wolman took on his third career as a consultant, advising such groups as the World Health Organization on various aspects of environmental and general public health policy.

Born on June 10, 1892, in Baltimore, Maryland, to Louis and Rose Wolman, Abel and his five siblings grew up in the Jewish section of East Baltimore. A product of the public school system, Wolman went to the Johns Hopkins University as a pre-med student, graduating in 1913. That same year, the university opened its engineering school. Urged by his mother to attend, Wolman enrolled in it, graduating in 1915. Wolman's association with Johns Hopkins would continue, essentially uninterrupted, for the next three quarters of a century.

Following his graduation in 1913, Wolman needed to work to pay for his engineering school tuition. He took a position with the U.S. Public Health Service studying water quality in the Potomac River. In 1914, he joined the Maryland Department of Public Health, where he was tasked with research investigations, frequently assisted by one of the department's chemists, Linn Enslow. In the course of one of these investigations, Wolman and Enslow developed the first standardized means of assessing chlorine absorption in water. It allowed for the use of chlorine in water supplies sufficient to kill pathogens yet not toxic to consumers. It may be the single most important publication in public health of the previous quarter millennium, and its use has likely saved hundreds of millions, if not billions, of lives.

An advocate of the use of rigorous statistical methods in sanitary engineering, Wolman edited the *Journal of the American Water Works Association and Municipal Sanitation*, as well as serving as an associate editor of the *American Journal of Public Health*. By 1922, he had become chief engineer in the Maryland Department of Health. One of his principal tasks was convincing the many towns in Maryland to chlorinate their water supplies; the high rates of typhoid fever in the United States and the emerging data suggesting major declines in those rates associated with chlorination aided his efforts. During the Depression, Wolman directed relief efforts in Maryland, including many public health infrastructure endeavors. Already an international authority on environmental engineering, he would insist that companies moving into Maryland adhere to environmental regulations, even at the risk of losing jobs.

In 1937, Wolman began his second career when he became the chair of the Sanitary Engineering Department at the Johns Hopkins School of Hygiene and Public Health, establishing the department. The school had weathered the death of Wade Hampton Frost the year before and Lowell Reed's departure from teaching to full-time administrative work. Wolman's appointment would commence the second generation of faculty at the school. Although his efforts would focus on his teaching from 1937 until his retirement in 1965, Wolman continued his advocacy efforts. He was instrumental in the development of the water supply system in Israel, as well as in other countries as well. In the post–World War II era, Wolman's efforts included the creation of professional public health organizations in Latin America, as well as infrastructure to support the work of sanitary engineers on that continent.

After Wolman retired from his administrative duties at Johns Hopkins, he maintained an active consulting practice, including advice for the World Health Organization as well as many corporations. But retirement did not mean Wolman stopped teaching. One of the editors (Lilienfeld) was fortunate enough to enjoy a weekly lunch with Wolman during 1976–1978; the discussions surrounding the meal ranged widely from how health policy is formulated (as contrasted with how it should be developed, in Wolman's view) to whether the development of slow sand filtration as a purification technique for water supplies was premised on an understanding of the germ theory or was simply an effort to remove visible particulates from the water.

Wolman's achievements in engineering and in public health generally were recognized in his election to the National Academy of Engineering, the National Academy of Sciences, the Sedgewick Medal from the American Public Health Association (of which he was a fellow), a special award of the Lasker Foundation, the U.S. National Medal of Science, and election as a fellow of the American Statistical Association. Wolman died in Baltimore on February 22, 1989.

A Note on the Text

The selected reading discusses the development of a standardized approach to assessing the amount of chlorine needed in a given specimen of water. Prior to the development of this approach, public health officials had no means of determining whether additional chlorine should be added to a water supply—that is, was the burden of pathogens in the water high (requiring more chlorine) or low? If low, and more chlorine is added, the health consequences in the population using the water could be dire. With this paper, public health officials had the means to safely add chlorine to water supply systems to markedly reduce the burden of pathogenic organisms without risk of compromising the health of the population.

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Chlorine Absorption and the Chlorination of Water
(1919)

Introductory

The disinfection of waters by means of various forms of chlorine has been practiced in this country and abroad for many years. During this period a general theory of chlorination has grown up, particularly on the side of the water, which has had little or no scientific basis. The general hypothesis concerning the effects of chlorination, the proper dosage, and the nature of the chemical and biological reactions have been deduced from a few well-controlled experiments on waters of certain characteristics. The results of these experiments, however, have led to the universal adoption of chlorination for waters differing materially from those upon which earlier experimental data were made available. When, therefore, a number of water supplies were treated with standardized doses of chlorine, or its compounds, failures in performance were soon recorded.

In the supervision and control of a single water supply, the problem of chlorination offers far less difficulty than in the case of a group of water supplies, all of which have distinctive and disconcertingly variable qualities. The control of disinfection of a city water supply, supported by daily chemical and bacteriological examinations, may at least approach a scientific procedure, although surprisingly few cities even at this late date actually do more than a superficial dosing at a more or less constant rate. The supervision of chlorination becomes, however, a problem of major importance where a large series of supplies are to be treated under the direction of some central authority, like a State Department of Health. With 10 or 15 water supplies—inadequately sampled, some in the raw state, some just after coagulation, some filtered, ranging through every degree of color and turbidity, now free from organic material and an hour later loaded with surface wash—what form of control should be adopted? Here [on, Ed.] a speedy, safe, easy method of antecedent chlorination, the preliminary routine control of widely different types of waters, the scientific literature, with some few exceptions, is silent.

In the State of Maryland, as in other States, experience indicates that, in general, chlorination control has been inadequately studied. When we bear in mind that a number of supplies are under the supervision of laymen, it becomes clear that consistently good results in disinfection are hardly attainable without the use of some presumptive indicator of an efficient chlorine dose. Presumptive tests of chlorine efficiency have been discussed by various students of the problem; but their contributions, although suggestive, have been based upon such meager experimental evidence that they cannot yet be considered definitive.

The present brief discussion is the result of a study, carried on during the past 18 months, of the application of chlorinators under variable conditions. The data here set forth are fragmentary. They are reported in order to invite attention to the extreme intricacy of the whole problem rather than as the basis of a formula designed to furnish the proper doses of chlorine and its allied compounds. It may be stated, however, that observation of the conditions in this State has served to point out a wide field for further intensive experimentation and, in this respect, the material here presented may be of some little value.

Absorption of Available Chlorine

The importance of the absorption of so-called "active chlorine" by different waters is somewhat ill-defined in its relation to disinfection or the elimination of objectionable bacterial life. Some experimenters assert that the amount of absorption disclosed little concerning the destruction of bacteria, while others assume that the chlorine consumed in "oxidizing organic matter and sometimes ferrous salts or sulfides will not effect sterilization."[1] Since the latter assumption necessarily permits an increased factor of safety in the control of the chlorination, it is probably advantageous to use the hypothesis as a base until the collection of adequate data indicates what quantitative variations therefrom may be necessary.

In order to study the significance of the absorption of chlorine by waters, it is of interest for scientific and practical purposes to obtain some idea of the factors which influence or predetermine the losses of chlorine in different waters. Owing to the complexity of conditions under which the action of chlorination proceeds, such data as the above and any conclusions pertaining thereto may be ascertained in only an empirical manner. A few apparently elementary features of chlorine absorption, therefore, are described briefly in order to establish at least some salient characteristics of the phenomenon of the disappearance of the active agency in chlorination.

The Rate of Chlorine Absorption. A few experiments were tried to determine the velocity of absorption of available chlorine by the same water during varying time intervals. The data were collected in order to compare with similar work reported by Race.[2] The results are set forth in Table 1. A comparison of these findings with the values reported by Race indicates that K, the velocity constant, in general, decreases with the time of contact. These values are in agreement with the conclusions noted by Race. It should be pointed out, however, that the value of K approaches a constant for different time intervals in those waters whose organic content is low. It appears, therefore, that the rate of chlorine absorption deviates from the ideal monomolecular law of chemical reaction in an increasing degree with waters of increased organic content. In other words, the monomolecular law with K constant is fairly well typified in those few waters which have only slight organic content, such as well and filtered waters, Nos. 13, 15 and 17. This is to be expected, since it is only in these latter waters that the compounds acted upon are probably of such simple chemical structure as to result in a constant reaction velocity.

Color and the Rate of Chlorine Absorption. The use of color readings as a presumptive indicator of the amount of chlorine which would be absorbed by a water in a given period has been suggested as a convenient procedure for routine operation of disinfectant plants. To be of any value, such readings should be the result of a long series of correlated experimental observations. Such continuous series have not been developed, it is believed, for many individual water supplies, while still less has been done in the way of comparative readings on different water supplies. Data upon this question are now being collected in this department. They are not reported in this paper on account of their insufficient number, but the evidence from the observations now available would seem to indicate that for the *same* water supply, changes in color are not necessarily concomitant with variations in chlorine absorption during a constant time interval, while for different water supplies the same conclusion is indicated as far as independent chlorine absorptions are concerned. It would appear, from the evidence now at hand, that color readings in different water supplies cannot be adapted to the reduction of chlorine absorption readings, because of the absence of any adequate conversion factor.

Turbidity and the Rate of Chlorine Absorption. In order to study the variation of chlorine absorption in a surface water within different ranges of turbidity, a series of 350 samples of the Potomac River water at Luke, Md., were examined during June and July, 1918. A study of turbidity readings and the chlorine absorption tests indicates practically no correlation whatever between these two phenomena, although the turbidities ranged from 0 to 90 parts per million.

The Potomac River water at the above station offers an interesting illustration of the necessity for guarding against unwarranted correlations between the physical properties of a water and its biochemical conduct. In the case of the above water, the chlorine absorption values (during five minutes) showed no increase whatever with increases of turbidity, but rather a slight decrease. That the absorption remained almost constant and even decreased, in a degree, with an apparent physical degradation of the water is

Table 1 Absorption of Chlorine by Waters at 20°C. Variations in *K* with Time

Sample		Values of $K = 1/t^2 - t^1 \log N_1/N_2$ for time intervals of 5 min.	30 min.	60 min.
1	Surface	0.052	0.009	0.005
2	Surface	0.069	0.012	0.008
3	Surface	0.032	0.013	0.007
4	Surface	0.041	0.013	—
5	Surface	0.082	0.018	—
6	Surface	0.066	0.017	0.009
7	Surface	0.071	0.013	0.013
8	Surface	0.082	0.023	0.015
9	Surface	0.032	0.011	0.007
10	Surface	0.099	0.026	—
11	Surface	0.036	0.015	—
12	Surface	0.017	0.007	—
13	Filtered	0.007	0.004	—
14	Well	0.014	0.005	0.003
15	Well	0.007	0.008	0.006
16	Well	0.013	0.003	0.002
17	Well	0.009	0.009	—
18	Surface	0.104	0.018	0.010
19	Surface	0.036	0.007	—
20	Surface	0.044	0.004	—
21	Surface	0.026	0.014	0.010
22	Surface	0.120	0.023	0.014

probably explained by the fact that the Potomac River at the point under discussion contains considerable oxidizable mine wastes. Sudden rainfalls create dilutions of these wastes, but at the same time raise the turbidity readings on the river. It comes about, therefore, that the increased muddiness in the water is in reality accompanied by a reduction in oxidizable material,

Table 1a Summary of Data in Table 1

Initial Chlorine Absorbed in 5 min.	Ratio K_5/K_{30}	Ratio K_5/K_{60}
0.08	1.8	1.1
0.08	1.1	—
0.10	1.0	—
0.14	4.3	6.5
0.15	2.8	3.3
0.18	2.4	—
0.26	1.8	1.3
0.31	2.5	4.6
0.31	2.9	4.6
0.34	2.8	—
0.34	5.1	—
0.38	3.2	—
0.40	11.0	—
0.45	5.9	10.4
0.53	3.9	7.3
0.55	5.6	11.5
0.56	5.5	5.5
0.61	4.6	—
0.61	3.5	5.5
0.68	3.8	—
0.710	53.8	10.4
0.75	5.2	8.6

without a consequent increase in chlorine absorption values. The situation is somewhat analogous to the reductions in alkalinity frequently observed with rises in turbidity. It is clear from the above situation that the direct variation of dosage with increase of turbidity would have been fallacious and contrary to the demand of the water. When the attempt is made to correlate turbidities of *different* waters with their corresponding chlorine absorptions, even less success is experienced. This situation is to be expected in different supplies, because of the variance in character and degree of watershed pollution. It may be postulated, as a preliminary conclusion, that turbidity readings are not a safe index of chlorine absorption for different water supplies, but may be adapted, with sufficient precautionary measures, to use for an individual supply. Even in the latter case, the conversion of turbidity to chlorine absorption is accomplished only after long studies of widely varying phases of the same supply.

Oxygen Consumed and the Rate of Chlorine Absorption. Inasmuch as the oxygen-consumed values of waters represent approximately the oxydizable compounds present in such supplies, it would seem that this chemical index should bear some relation to the complex action of the chlorine absorption, of which some portion at least partakes of the nature of an oxidation. In order to study this phase of absorption, a series of widely varying waters, of surface and underground types and of different ranges of pollution, were examined during portions of 1917 and 1918. In all of these waters the oxygen-consumed and the chlorine-absorbed (5 min.) values were obtained. These readings are graphically shown on Chart 1 [Chart 1 not shown. Ed.], where the individual and average values have been plotted, in order to permit the construction of an empirical curve. The data there shown apparently disclose a fairly close variation of chlorine absorption with the oxygen-consumed values of different supplies. This correlation, it should be emphasized, is independent of the source or nature of the water, since the 45 waters tabulated include those from raw surface streams, deep wells, and filtered supplies.

The empirical curve indicates at once that the amount of chlorine absorbed in a definite time interval does not increase in direct proportion with the increase in pollution of the water (as measured by the oxygen-consumed test), but that the 5 minute rate of chlorine absorption shows a decreasing acceleration with increases in pollution. In other words, increases in oxygen-consumed values appear to result in *relative* decreases in the intervals between successive chlorine absorption values. This phenomenon is made clearer by reference to Table 2, wherein are compared certain values obtained form the empirical curve shown in Chart 1.

The apparent correlation discussed above has considerable practical importance aside from its use in the chlorination of water supplies. Its probable existence may result in the development of an extremely rapid presumptive indicator of the quality of a water, namely, its chlorine absorption in a definite time interval. It has been found comparatively simple, in this laboratory, for instance, to differentiate between an underground supply of good quality and a comparatively poor surface supply, simply by means of a chlorine absorption test made in 5 minutes. The information gained would seem to be capable of wider application to the entire field of water treatment. As a rapid diagnostic index of changes in quality of water supplies, the chlorine absorption test appears to offer a fruitful field for investigative effort.

Table 2 A Comparison between Chlorine Absorption Intervals and Equal Oxygen-Consumed Intervals

Oxygen Reading	Consumed Interval	Chlorine Reading	Absorbed Interval
.5	—	0.117	—
1.0	.05	0.211	0.094
1.5	.05	0.290	0.079
2.0	.05	0.350	0.060
2.5	.05	0.402	0.052
3.0	.05	0.449	0.047
3.5	.05	0.488	0.039
4.0	.05	0.520	0.032
4.5	.05	0.550	0.030
5.0	.05	0.577	0.027
5.5	.05	0.600	0.023
6.0	.05	0.620	0.020
6.5	.05	0.635	0.015
7.0	.05	0.652	0.017

Chlorine Absorption and Effective Disinfection Dosage

The practical effectiveness of any chlorine treatment is necessarily measured and conditioned by its ability to eliminate the significant bacterial life in the water. The preliminary determination of a dose which may be subsequently found to be effective has been the primary objective of past investigations in this field. In practically all of these methods of presumptive testing for effective dosage, chlorine absorption tests have played an important role. It is of interest, therefore, at this point to review briefly several of the methods of chlorine control now in use and to discuss the principles underlying their application.

American practice in the chlorination of water supplies has always been sharply differentiated from the foreign. In general, the foreign sanitarians have employed chlorine doses appreciably higher than those in use on this continent. This policy has been the result of a conservative conception of the whole question of chlorination and has therefore left its impress upon the modern systems of chlorination control. A study of the various methods of presumptive tests for the effective doses discloses the common assumption, independently promulgated, that the chlorine absorption in definite intervals bears some definite but apparently unknown relation to disinfection accomplishment. This definite relationship is, however, the subject of a wide difference of opinion among individual sanitarians, with always the sharp demarcation between the foreign and domestic viewpoints.

The principle underlying practically all of the chlorination control procedures is that of measuring the amount of available chlorine absorbed by the water to be disinfected in a given period of time. To this amount a factor of safety is usually added, giving a resultant so-called effective chlorine index. It is clear that the important element in the above procedure is the time element. The time interval taken for the measurement of the chlorine absorption is dependent upon the consideration of the death rate of the bacteria under the particular conditions. A dose measured in the light of the above principle is a safe dose only if the time interval used in its evaluation is amply sufficient to provide for adequate bacterial destruction. The problem of measurement of chlorine dosage resolves itself, therefore, into the question, "What is the safe time interval for the chlorine absorption test?"

The literature of chlorination suggests various answers to this question. Adams,[3] in his discussion of the chlorination of the water for Toronto, Canada, seems to assume that 3 minutes (plus a factor of safety) is a sufficient time interval for such a test. The basis for his criterion is not apparent. He states, however, that "by conducting a series of tests it was determined that Color No. 2 represented a surplus of chlorine in the finished water that would guarantee efficiency in bacterial destruction at all times, and in the great majority of cases would not give taste or odor, and under no circumstances a bad taste or odor." Color No. 2 was equivalent to the intensity of color existing with a definite excess of available chlorine.

That such a short time interval as the above is not universally applicable is evidenced by a survey of the data reported by Race.[4] It would appear from a number of the experiments there cited that effective sterilization or even approximately fair destruction is frequently not obtained even after a 60-minute interval. The application of a 3-minute absorption test to such a condition would demand, of course, an auxiliary factor of safety of high proportions in order to eliminate the danger of ineffective dosage.

Dienert,[5] of the city of Paris, France, approaches this problem in the conservative manner suggested in the preceding statement. He not only stipulates factors of safety abnormally high in comparison with American practice, but uses in addition a chlorine absorption time interval of 15 minutes. His procedure of presumptive testing is of sufficient interest to quote at length in this discussion. His statements follow:

> For the treatment of water we use always a quantity of available chlorine equal to that absorbed in a quarter of an hour increased by 0.5 ppm. We estimate that to sterilize a clear water with a quantity of chlorine determined as we have just said, 3 hours' contact are necessary. If, for certain reasons, we are obliged to distribute water before this delay, we must increase the quantity of chlorine and bring it up to 1.00 instead of 0.5 ppm.
>
> Thus, let us take a water whose absorption of available chlorine in a quarter of an hour is equal to 0. If the water must be distributed in a very short time we would add 1.2 ppm in order to sterilize it. If we should store the water longer than 3 hours, we would use only 0.2 + 0.5 = 0.7 ppm of available chlorine.
>
> We have established, in following the bacterial content of river or turbid waters treated with doses of free chlorine of from 1.00 to 1.5 ppm, that at certain moments *E. coli* was not destroyed. Safety in treatment demands the use of a dose of free chlorine a little higher than the doses given above.

Professor Santoliquido,[6] of Italy, adds to the general theory by stating that "the bacterial action of chlorine is not instantaneous for any particular bacterium; in order that the action should result, there is always necessary a contact period, which, at a minimum, must be from 10 to 20 minutes."

Costa and Pecker[7] modify somewhat the system of presumptive test for chlorine dosage by eliminating the factor of safety and using their so-called "chlorine index." The index appears to differ but slightly, in its evaluation, from the usual chlorine absorption tests reported by other authors in our own discussion. They establish as a principle or hypothesis that the useful dose for the purification of water is determined by the total quantity of chlorine fixed by the water in a given time and under definite conditions. They have determined, as a result of experience, that the initial dose of chlorine to be used in evaluating their index should be 5 ppm. As to the period of contact for the test, the authors have taken the figure of 30 minutes, which they state "is generally adopted for the purification of water by chemical substances."

These authors declare further, that they have been able to decide after more than 2 years' experimental work that the sterilization of water is not very often obtained if the quantity of chlorine used does not reach the figure fixed by the index, and that these latter figures give quantities sufficient for purification.

The foregoing discussion seems to indicate the absence of any general agreement either as to the necessary time interval for the chlorine absorption test or the relative scale of factor of safety. The evidence as to the velocity of bacterial destruction under widely varying conditions is far from complete. If the rates of disinfection on Chart 2 (experimental data) [Chart 2 not shown. Ed.] are approximately as shown, it would seem that a 30-minute absorption plus a high factor of safety is hardly necessary. It is doubtful, too, whether such factors of safety as 0.5 to 1.00 ppm can be universally employed under such conditions as exist in Maryland, where frequently the period of contact before consumption is so brief as to preclude a dose which would result in such excessive amounts of free chlorine in the tap.

A general survey of this phase of chlorination discloses a need for additional data regarding the velocities of disinfection under actual operating conditions. That the conceptions of this phase are inadequately developed is evidenced by the wide discrepancy in the phenol coefficients of chlorine, for example, quoted in current literature.[8]

Five or Thirty Minute Absorption Test?

For practical purposes, any rapid method of presumptive indication of efficient dosage is particularly valuable. It remains to be determined, however, whether the substitution of a rapid 5- for a safer 30-minute test will result in any practical diminution of a necessary safety factor. The demonstration of such an effect either in the positive or negative direction would demand manifestly far more experimental proof than the present writers are in a position to adduce.

It is of interest, however, in connection with this problem, to refer to the experimental data shown in Table 3 and Chart 3 [Chart 3 not shown. Ed.]. These experiments[9] were designed to answer in a preliminary manner the question as to the effect of increased time intervals upon the total amounts of available chlorine absorbed by different waters. In other words, what additional information is gained by extending absorption tests from 5 to 30 or 60 minutes? Chart 3, with its few empirical values, seems to suggest that the importance of increasing the period of test decreases materially with the increased values of the initial 5-minute absorptions. The evidence in Table 3 would appear to point to the conclusions that increased safety in dosage is occasioned by the 30-minute test in those waters where the factor of safety is least essential, whereas little additional safety is gained in waters of higher initial absorption or in those where it is most necessary.

If the 5-minute chlorine absorption test is at all indicative of the pollute content of a water, then the evaluation of a 30-minute test seems to add but little necessary information as to effective dosage. It would hardly be advantageous to use a 30-minute test, in preference to a 5, when the former increases greatly the dosages for good waters and affects but little those of poorer waters. The addition of a constant factor of safety, as, for

Table 3 Showing the Additional Percentages of Available Chlorine Absorbed by Different Waters in Increased Time Intervals

Sample		Initial Dose of Chlorine = 1.00 ppm			Temperature 20°C	
		Per cent. of Initial Chlorine Absorbed in			Ratio of Per cent. Chlorine Absorbed	
		5 min.	30 min.	60 min.	30 min. to 5 min.	60 min. to 5 min.
1	Surface	45	47	50	1.04	1.12
2	Surface	55	57	58	1.04	1.06
3	Surface	31	60	62	1.95	2.00
4	Surface	38	60	—	1.59	—
5	Surface	61	71	—	1.17	—
6	Surface	53	70	72	1.32	1.36
7	Surface	56	61	84	1.09	1.50
8	Surface	61	79	88	1.21	1.44
9	Surface	31	53	63	1.71	2.02
10	Surface	68	84	—	1.24	—
11	Surface	34	59	—	1.74	—
12	Surface	18	39	—	2.15	—
13	Filtered	08	25	—	3.22	—
14	Well	15	30	38	2.00	2.53
15	Well	08	42	56	5.25	7.00
16	Well	14	18	24	1.29	1.71
17	Well	10	45	—	4.50	—
18	Surface	70	72	75	1.03	1.08
19	Surface	34	37	—	1.09	—
20	Surface	40	40	—	1.00	—
21	Surface	26	64	75	2.48	2.90
22	Surface	75	80	85	1.07	1.14

instance, 0.2, to the 5-minute absorption value would apparently accomplish the same result in the routine control of chlorination as the use of a longer absorption time interval.

Source

Wolman, Abel, and Linn H. Enslow. "Chlorine Absorption and the Chlorination of Water." *Journal of Industrial and Engineering Chemistry* 11.3 (1919): 206–213.

AFTERWORD

I cannot say whether things will get better if we change; what I can say is they must change if they are to get better.

—Georg Christoph Lichtenberg, (1742–1799) German physicist and aphorist

This volume contains but a few of the many historical works that led to the development of public health as a discipline, primarily those that instigated changes in the Western world. We selected readings by individuals whose work we felt was seminal, but our choices may not perfectly match those of others who teach the history of public health. We did not, for example, include Zabdiel Boylston's experiment with variolation in Boston (1721), nor did we include Johann Peter Frank's *The People's Misery: Mother of Diseases* (1790), an academic address identifying poverty as the root of disease. We did not include Florence Nightingale's *Notes on Nursing* (1860), a key document for the development of nursing as a profession. Also missing is Carlos Juan Finlay's *The Mosquito Hypothetically Considered As An Agent In The Transmission Of Yellow Fever Poison* (1881), a cornerstone piece that helped determine the etiology of that disease. We wish we could have included all of the above and more, but the reality is that it would be impossible to cover them all over the course of one semester. For readers seeking a more thorough discussion of the development of the discipline, we recommend reviewing some of the histories of public health, many of which have been published in recent years. Indeed, histories of public health, read in conjunction with the original documents contained in this volume, provide the best overview of how the field of public health emerged and took hold in the late nineteenth and early twentieth centuries.

The rise of public health in the Western world parallels the rise of industrialization and civil engineering. It strove to address problems with "the great unwashed" and attempted to raise the standard of living for entire populations. Public health assured a moderately healthy work force, provided some security against epidemic diseases, and helped move a rapidly industrializing Western world towards a cleaner, somewhat safer and more humane human environment. Those challenges remain for many parts of the developing world today.

As we began working on Volume II, we noted that individuals became less important to the development of public health in the twentieth century than did social, economic, and political movements of the time. Technologies, communications, and public works arose that changed the course of history. The World Health Organization took root, and global efforts eradicated the scourge of smallpox. Rapid transport and communication, international trade, and green movements changed the way human beings viewed the planet. With this in mind, Volume II is being formulated to cover thematic works in public health rather than those of particular individuals. The time span for Volume II covers the twentieth century. As with Volume I, we believe there is merit in reading original works, not only later commentary on their importance. Thus, we again recommend that the reader take on Volume II with the expectation that it can be augmented by other sources, such as modern histories of public health, public health and public policy texts and journals, and other media resources. Only by casting a broad net can the student of the history of public health piece together all that drove the changes in the discipline.

APPENDIX I

GREAT LEADERS OF THE PUBLIC HEALTH MOVEMENT IN AMERICA

Scientific Work	Henry I. Bowditch C. F. Chandler J. S. Billings
Practical Workers in the Field	E. M. Snow J. M. Toner Elisha Harris H. B. Baker Stephen Smith

Source: W. G. Smillie, *Public Health: Its Promise for the Future* (New York: Macmillan, 1955). The information is attributed to Ezra M. Hunt, chairman of the Section on State Medicine and Public Health of the American Medical Association (1877) (p. 484).

PIONEERS IN AMERICAN PUBLIC HEALTH, 1610–1925

Editorial Note: The following tables are compiled from the *American Journal of Public Health* 43.9 (1953) and W. G., Smillie, *Public Health: Its Promise for the Future* (New York: Macmillan, 1955), pp. 473–487. To qualify as a pioneer, an individual had to have completed their major life work by 1925. Individuals on the Master List (Table 1) were selected as the five most worthy by experts in their respective fields. The list was then reduced to the Outstanding Pioneers (Table 2) who "had contributed most effectively to the development of public health in America." Finally, these individuals were prioritized to obtain the top 25 across all fields (Table 3). Judges were G. Anderson, L. Baumgartner, H. Emerson, I. Galdston, H. R. Leavell, H. S. Mustard, G. Rosen, R. H. Shryock, F. H. Top, and C-E. A. Winslow.

Table 1 Master List of Pioneers in Public Health in America, 1610–1925

Field	Candidates				
Communicable Disease Control	Jacob Bigelow	B. Waterhouse	Zabdiel Boylston	W. T. Sedgwick	V. C. Vaughan
Quarantine	Wilson Jewell	J. H. Griscom	Elisha Harris	A. N. Bell	J. M. Woodworth
Tuberculosis	Theobald Smith	H. I. Bowditch	Hermann Biggs	E. L. Trudeau	M. P. Ravenel
Malaria-yellow fever	Daniel Drake	G. M. Sternberg	Walter Reed	Henry Carter	W. C. Gorgas
Other contagious diseases	W. W. Stiles	A. L. Gihon	William H. Park	Simon Flexner	H. T. Ricketts
Diagnostic labs	Hermann Biggs	William H. Park	G. T. McCoy	G. M. Sternberg	V. C. Vaughan
Immunology	Theobald Smith	Simon Flexner	F. F. Russell	V. C. Vaughan	H. T. Ricketts
Epidemiology	W. H. Frost	Hibbert W. Hill	L. L. Lumsden	E. O. Jordan	W. T. Sedgwick
Sanitation	Noah Webster	W. T. Sedgwick	Elisha Harris	George Whipple	A. G. Clark
Sanitary engineering	W. R. Nichols	Hiram Mills	J. P. Kirkwood	Rudolph Hering	William C. Hazen
Food sanitation	E. O. Jordan	H. S. Wiley	H. W. Conn	B. H. Ransom	Samuel Prescott
Milk sanitation	M. J. Rosenau	H. W. Conn	William A.Evans	Charles E. North	H. L. Coit
Housing	George M. Kober	Stephen Smith	Jacob Riis	V.C. Vaughan	Lemuel Shattuck
Industrial hygiene and sanitation	Geroge M. Kober	Alice Hamilton	Andrew H. Smith	Gilman Thompson	William C. Hanson
Health Organization Administration	Lemuel Shattuck	H. I. Bowditch	Stephen Smith	Charles V. Chapin	J. M. Woodworth
Rural health	Ezra Hunt	L. L. Lumsden	Wycliffe Rose	W. S. Leathers	C. W. Stiles

Municipal health	Stephen Smith	Hermann Biggs	Charles V. Chapin	J. H. Rauch	Edwin Snow
State health	Erastus Brooks	R. C. Kedzie	Lemuel Shattuck	H. I. Bowditch	Thomas M. Logan
National health	J. M. Woodworth	Stephen Smith	J. H. Rauch	J. S. Billings	G. M. Sternberg
Vital statistics	Lemuel Shattuck	E. Wigglesworth	J. S. Billings	Cressy Wilbur	Elisha Harris
Maternal-Child Health	Julia Lathrop	Josephine Baker	Phillip Van Ingen	O. W. Holmes	Henry Koplik
Infant care	A. Jacobi	Emmett Holt	Lucien Howe	Josephine Baker	J. H. M. Knox
School health	D. F. Lincoln	S. H. Durgin	R. J. O'Sullivan	Ellen Richards	Thomas Wood
Public Health Nursing	Lillian Wald	Mary Gardner	Mary Beard	Alfred Worcester	Lina Rogers
Mental Hygiene	Benjamin Rush	Edward Jarvis	Dorothea Dix	Clifford Beers	Thomas W. Salmon
Health Education	Benjamin Franklin	E. Routzahn	A. N. Bell	Hermann Biggs	Lemuel Shattuck
Training for Public Health as a Career	V. C. Vaughan	W. H. Welch	W. T. Sedgwick	George Whipple	M. J. Rosenau
Nutrition	Joseph Goldberger	Graham Lusk	Nathan Strauss	A. F. Hess	H. C. Sherman
Public Health Law	Dorman B. Eaton	H. G. Clark	Erastus Brooks	J. Ordronaux	Lemuel Shattuck
Voluntary Organizations	Clara Barton	L. F. Flick	Hermann Biggs	L. Schuyler	Fred T. Gates

Table 2 Outstanding Pioneers in Each Field of Public Health, 1610–1925

Field		Name	Principal Contributions
Communicable Disease Control		V. C. Vaughan	Epidemiology of Spanish War, typhoid fever, immunology, public health teacher
	Quarantine	Wilson Jewell	Organized Quarantine Convention, 1857
	Tuberculosis	Hermann Biggs	Began basic services in tuberculosis control
	Malaria-yellow fever	Daniel Drake	Diseases of interior valley of North America, 1850
	Other contagious diseases	C. W. Stiles	Epidemiology of hookworm disease
	Diagnostic labs	William H. Park	Established municipal diagnostic laboratories
	Immunology	Theobald Smith	America's greatest medical scientist
	Epidemiology	W. H. Frost	America's greatest epidemiologist
Sanitation		W. T. Sedgwick	Outstanding pioneer in general sanitation, brilliant teacher
	Sanitary engineering	Rudolph Hering	Father of American sanitary engineering
	Food sanitation	E. O. Jordan	Elucidation of food poisoning
	Milk sanitation	M. J. Rosenau	Pasteurization of milk
	Housing	Stephen Smith	Sanitary Survey of New York City, 1966
	Industrial hygiene and sanitation	Alice Hamilton	Industrial toxicology

Health Organization Administration		Lemuel Shattuck	Shatttuck report, 1850
	Rural health	Ezra Hunt	Originated concept of rural health department
	Municipal health	Charles V. Chapin	America's greatest municipal health officer
	State health	Lemuel Shattuck	Originated concept of state health department
	National health	J. M. Woodworth	Founded Marine Hospital Service, which became the U.S. Public health Service
	Vital statistics	J. S.Billings	Established vital statistics in America
Maternal-Child Health		Josephine Baker	Developed child health as a municipal function
	Infant care	A. Jacobi	Father of American pediatrics
	School health	Samuel Durgin	Established medical school inspection
Public Health Nursing		Lillian Wald	Founded "Henry Street Settlement"
Mental Hygiene		Dorothea Dix	Pioneer in provision for care of mental illness
Health Education		Hermann Biggs	Developed modern concepts of health education
Training for Public Health as a Career		W. H. Welch	Established Johns Hopkins School of Hygiene
Nutrition		Joseph Goldberger	Pellagra studies
Public Health Law		Dorman B. Eaton	Basic public health law
Voluntary Organizations		Clara Barton	Founded the Red Cross

Table 3 Final List of Outstanding Pioneers in the Development of Public Health in America, 1610–1925

1	Lemuel Shattuck	1793–1859	Founder of public health in America. Recommended state and municipal health organizations on a full-time basis, vital statistics, nurses' training, public health training, popular health education, etc.
2	Theobald Smith	1859–1934	Immunologist, bacteriologist, tuberculosis control. Founded state biological products laboratory.
3	William T. Sedgwick	1855–1921	Sanitarian, epidemiologist, public health teacher.
4	Stephen Smith	1823–1923	Founder municipal health service; also cofounder, National Board of Heath and American Public Health Association.
5	William H. Welch	1850–1934	Public health statesman, bacteriologist, public health teacher.
6	Wade H. Frost	1880–1938	Established epidemiology as a science in America.
7	John S. Billings	1839–1913	Epidemiologist, vital statistician, cofounder, National Board of Health; librarian, hospital administration.
8	Charles V. Chapin	1856–1941	Communicable disease control, municipal health administration.
9	Walter Reed	1851–1902	Determined transmission of yellow fever by a mosquito.
10	Hermann M. Biggs	1859–1923	State and municipal health administration, tuberculosis control, health education.
11	Alice Hamilton	1869–1970	Industrial hygienist, particularly toxicology.
12	George M. Sternberg	1833–1915	Diagnostic laboratories, bacteriology, malaria, yellow fever, national health administration.
13	Lillian Wald	1867–1940	Established public health nursing in America.
14	Oliver Wendell Holmes	1809–1894	Epidemiology, "Contagiousness of Puerperal Fever."
15	Dorothea Dix	1802–1887	State and national responsibility for care of persons with mental illness.

16	Benjamin Waterhouse	1753–1846	Introduced smallpox vaccine in America.
17	John M. Woodworth	1837–1879	Organized Marine Hospital Service, 1872, which became U.S. Public Health Service.
18	Josephine Baker	1874–1945	Established child health protection as a function of municipal government.
19	Charles W. Stiles	1867–1941	Discovered hookworm disease in the South and led development of rural sanitation in America.
20	Howard T. Ricketts	1871–1910	Pioneer work in virus disease, etiology, epidemiology, and control of Rocky Mountain spotted fever.
21	Daniel Drake	1785–1852	Epidemiology of malaria in America.
22	Victor C. Vaughan	1851–1929	Pioneer in immunology, epidemiology, sanitation, and teaching of public health.
23	Milton J. Rosenau	1869–1946	Teacher of preventive medicine and public health, epidemiologist, milk sanitation.
24	George M.Kober	1850–1931	Initiated industrial medicine, exponent of housing, a teacher of public health in medical colleges.
25	William H. Park	1863–1939	Communicable disease control, diphtheria immunization, diagnostic laboratories.

NOTES

PART I

Chapter 1 HIPPOCRATES

1. Francis Adams (1849, p. 156) says, “The part in parenthesis is rather obscure.” W.H.S. Jones (1923, p. 71) translates the same passage as “for the seasons are not at all alike, but differ widely both in themselves and at their changes.” [Ed.]
2. W.H.S. Jones translates this to “brackish and harsh.” [Ed.]
3. Consisting of, or resembling, pituite or mucus; full of mucus; discharging mucus. [*Webster's Unabridged Dictionary*, 1913]
4. Francis Adams comments, “Dentition brings prominently into view the connection between infancy and convulsions” (p. 158). [Ed.]
5. Ibid. “[A] species of intermittent fever, very common in warm climates. It would appear to be a variety of the quotidian” (p. 158). [Ed.]
6. Adams claims this is a disease of the skin, perhaps a variant of eczema (p. 158). [Ed.]
7. A wasting or consumption of the tissues. The term was formerly applied to many wasting diseases, but is now usually restricted to pulmonary phthisis, or consumption (tuberculosis). [*Webster's*]
8. Edema. [*Stedman's Medical Dictionary,* 27th ed., 2000]
9. This has been alternatively translated as “a small distance” by Francis Clifton, 1834. [Francis Adams's footnote]
10. Francis Adams claims this alludes to scurvy (p. 161). [Ed.]
11. Occurring every fourth day, as a quartan ague (malaria) or fever. [*Webster's*]
12. Francis Adams claims this is a variant of dropsy (edema) (p. 161). [Ed.]
13. Slow, painful urination, caused by muscular spasms of the urethra and bladder. [*American Heritage® Dictionary of the English Language*, 4th ed., 2000]
14. The Dogstar (Sirius) rises in the Mediterranean region during midsummer. [Ed.]
15. Fevers, especially malaria. [Ed.]
16. Ulcerous. [*Stedman's*]
17. Of the spleen. [*Stedman's*]
18. Gangrene. [*Webster's*]
19. Arcturus (Alpha Bootis) is one of the brightest stars, shining with a soft orange light in northern spring skies. [Ed.]
20. Pleiades is a star cluster (the Seven Sisters and Messier 45) that, in the Northern Hemisphere, reaches its highest point in the sky around 4:00 AM in September, midnight in November, and 8:00 PM in January. [Ed.]
21. W.H.S. Jones indicates the author is referring to Asia Minor (p. 105). [Ed.]
22. Francis Adams claims a lacuna in the text: “A chapter devoted to an examination of the peculiarities of the Egyptians and Libyans is evidently lost” (p. 170). [Ed.]

23. The Sea of Azov (Palus Maeotis) is the northern arm of the Black Sea, c. 14,000 sq. mi. (36,300 sq. km.), shared by S. European Russia and E. Ukraine. [*The Columbia Encyclopedia*, 6th ed., 2001]
24. The location of the Macrocephali is unknown, but Francis Adams claims that Kertch, in the Crimea (not far from the Palus Maeotis), found excavated skeletons with remarkably elongated heads (p. 171). [Ed.]
25. Ancient city (now Rion) and river, c. 195 mi. long, along the eastern shore of the Black Sea, at the foot of the Caucasus. [*Columbia*]
26. Francis Adams claims this was a nearly unexplored country extending from the Baltic Sea to the Black Sea, comprising a large portion of Russia, Poland, and perhaps Prussia (p. 174). [Ed.]
27. Adams states the passage "applies to the wandering tribes which roam over the steppes of Tartary" (p. 175).
28. Ursa Major and Minor. [Ed.]
29. A prominent range of Sarmatian (central-eastern) Europe; home of the mythical gryphon (a creature with the head, wings, and talons of an eagle and the body of a lion) and the more recent hippogryph, or hippogriff (the product of a male gryphon and a female horse), created for the Harry Potter books by J. K. Rowling. [Ed.]
30. Sexual intercourse. [*Heritage*]

Chapter 2 GRAUNT

1. A yellow staining of the skin and the whites of the eyes due to abnormally high levels of bilirubin. [Ed.]
2. A stress-induced heart attack or stroke. [Ed.]
3. Lockjaw (tetanus). [Ed.]
4. Abscesses. [*Webster's Unabridged Dictionary*, 1913]
5. A fever marked by paroxysms of chills, fever, and sweating recurring at regular intervals. [*Webster's*] Also malaria. [Ed.]
6. Sudden diminution or loss of consciousness, sensation, and voluntary motion, usually caused by pressure on the brain. [*Webster's*] Also stroke. [Ed.]
7. A severe headache. [*Glossary of Old Names*, www.bignell.uk.com/glossary_of_old_names.htm] [As from a cerebrovascular accident (CVA) or migraine. Ed.]
8. Scrofula, a tubercular infection of the throat lymph glands; also sometimes syphilis. [*Webster's*]
9. Rabies. [Ed.]
10 Fatigue, possibly due to anemia or wasting. [Ed.]
11. An enlarged liver, possibly from cirrhosis or other reasons. [Ed.]
12. Various terms for dysentery or severe diarrhea. [Ed.]
13. Suicide. [Ed.]
14. An eating ulcer or sore. Cf. Lupus. [*Webster*] Also, a rapidly expanding (aggressive) growth. [Ed.]
15. Smothered in bed; failure to thrive. [Ed.]
16. A severe, destructive, eroding ulcer of the cheek and lip, perhaps Herpes simplex. [*Homéopathe International*, www.homeoint.org]
17. Loss of sensation, motion, or both, in one or more parts of the body. Perhaps the residual of stroke. [Ed.]
18. Fever due to an infection, usually of the placenta. Also called childbed fever or puerperal fever. [Ed.]

19. Hemorrhoids. [Ed.]
20. This term likely refers to the death of a newborn or a stillbirth (a child that died before baptism). [Ed.]
21. Sideratio. Any sudden severe affliction or paralysis as if by the influence of the stars or planets. [*Antiquus morbus,* www.antiquusmorbus.com]
22. Kidney, bladder, or gallstones. [Ed.]
23. A condition marked by slow, painful urination, caused by muscular spasms of the urethra and bladder. [*American Heritage® Dictionary of the English Language*, 4th ed., 2000]
24. Tuberculosis. [Ed.]
25. A febrile disease with a skin eruption, such as typhus, cerebral meningitis, Rocky Mountain Spotted Fever, Boutonneuse Fever, and others. [*Dorland's Medical Dictionary*, 2002]
26. Tonsillitis. [Ed.]
27. The surgical removal of bladder stones. [Ed.]
28. "Lights" is a term for lungs. The term most likely refers to breathlessness or croup. [Ed.]
29. Pain usually caused by a herniated disk of the lumbar region of the spine and radiating to the buttocks and to the back of the thigh. [*Heritage*]
30. Edema. [Ed.]
31. Severe vitamin C deficiency resulting in weakness, spongy gums, and hemorrhages under the skin. [Ed.]
32. Gluttony. [Ed.]
33. Epilepsy. [Ed.]
34. Varicella. [*Antiquus morbus*]
35. Distention of the abdomen resulting from the accumulation of gas or air in the intestine or peritoneal cavity. [*Heritage*]
36. Syphilis. [Ed.]
37. Cough. Tuberculosis. [Ed.]
38. Tuberculosis. [Ed.]
39. A daily recurring fever with profound sweating, chills, and flushed appearance often associated with malaria, pulmonary tuberculosis or septicaemia. [*Archaic Medical Terms*, www.paul_smith.doctors.org.uk]
40. A form of primary anemia affecting mostly girls at the period of puberty or early womanhood, and characterized by a marked deficiency of hemoglobin in the red corpuscles; Green Sickness. [*CancerWEB*, http://cancerweb.ncl.ac.uk]

Chapter 3 LIND

1. Ended ann. 1748. [Author footnote]
2. Term used mainly for ferrous sulfate ($FeSO_4$), but a generic term for sulfates. [*Incompleat Chymist,* http://dbhs.wvusd.k12.ca.us/webdocs/Chem-History/Obsolete-Chem-TermsTOC.html]
3. A medicine composed of powders, or other ingredients, incorporated with some conserve, honey, or sirup; a confection. [*Webster's Unabridged Dictionary*, 1913]
4. Potassium Hydrogen Tartrate, $KHC_4H_4O_6$ or $C_4H_5KO_6$ [*An Alchemists Glossary of Terms, Definitions, Formulas & Concoctions*, http://www.3rd1000.com/alchemy/alchemyterms.htm]
5. Extract of a letter from Mr. Ives:

"I judge it proper to communicate to you, what good effects I have observed in the scurvy, from the use of cider and sea-water, during the last cruise I made in the western squadron, with my honoured benefactor Admiral Martin. But as I do not pretend to have taken any notice of any thing more than merely a palliative benefit from them, I think, without mentioning particular cases, it will be sufficient for me to inform you, that in our preceding cruise with the western squadron, his Majesty's ship Yarmouth, of 70 guns and 500 men, was not only distressed with the scurvy in common with other ships, but, in spite of all my endeavours, lost in it a proportioned number of men. Upon our return from that cruise, I took the opportunity to represent to the Admiral, that as vegetable juices of all forts were from experience found to be the only truly antiscorbutics, and I had myself formerly experienced the good effects of apples, it was reasonable to presume that cider must certainly be of service. This suggestion agreed with some accounts the Admiral had received from others; and he with great readiness bought, and put under my care, several hogsheads of the best South Ham cider. During the next cruise, each scorbutic patient had daily a quart or three pints of cider; and as many of them as I could prevail on, took twice-a-week three quarters of a pint of sea-water in a morning. In all other aspects I treated them as I used to do patients in the scurvy; which you well know from the conversation which has often passed betwixt us on this subject, was with squill vomits, pills composed of soap, squills, garlic, &c. elixir vitriol. And other medicines suited to the different stages and symptoms of the malady. In one word, we had, this cruise, as many scorbutic patients as any other ship, in proportion to our complement of men. But although all the rest buried a great many, some to the number of 20, others 30, 40, 50, and upwards; yet the Yarmouth did not bury more than two or three; and these at the latter end of the cruise, all our cider having been expended for a week or ten days before. Upon our arrival at port, we sent to the hospital a great many in very dreadful circumstances." [Author footnote] [Squill is *Urginea maritime*, a bulb of the lily family that was used both medicinally and as a rat poison. Ed.]

6. Occurring or returning daily; as, a quotidian (malarial) fever. [*Webster's*]

Chapter 4 BAKER

1. All the Latin and French phrases in The Delta Omega Society 1958 version were translated by I. F. Gratch, M.D., and included as footnotes in that version. This phrase was translated as "which are in front of [our] feet." [Ed.]
2. " 'Empirics,' on the basis of experience, it does not matter what produces the disease, so much as what removes it." [Gratch]
3. "The knowledge of the cause removes the disease." [Gratch]
4. "To deceive and run away is a triumph." [Gratch]
5. "Quite different colic is caused by too much use of a strong and acid cyder, among the Damnoniums (inhabitants of Devonshire?); it is clear, indeed, that it affects only those who are accustomed to consume it, and in proportion of

the use of it; during periods of time when apples are abundant, the populace is more affected; on the other hand, when Pomona [goddess of fruit] is less generous, the illness is observed less often." [Gratch]

6. ". . . of a young age, who experienced a colic, which is called Pietonica (colic of Poitou?), after the usual course of this illness, began showing signs of paralysis; had flaccid limbs; remained infirm for the rest of his life. In the beginning, paralysis was accompanied by vague pain, in joints, particularly in autumn and during the rainy season, imitating rheumatism." [Gratch]
7. Multiple commentaries indicate that Huxham (1738) most likely used the term *Damnoniorum* (*Dumnonia* in Celtic) to refer to Devonshire. [Ed.]
8. I am credibly informed, that, at this time, both in the West Indies, and in the northern colonies of America, the juice of lemons and limes is not only much trusted as the cure of this disease, but that it is esteemed to be a preservative from it. [Author footnote]
9. Bile. [Ed.]
10. See Dr. Huxham's treatise on the Devonshire colic, translated from the Latin original, and published with the Doctor's approbration. [Author footnote]
11. "Without experience, any theory is void, no matter how pretty it appears." [Gratch]
12. "Analysis of a book which has for a title 'T. Tronchin about the Colic or Poitou by a physician of Paris.' " [Gratch]
13. "It is possible that wines, of which speaks Citois, and the ciders, of which speaks M. Huxham, have been (without which this could not have been discovered) altered [adulterated?] with lead, or with some other similar substance." [Gratch]
14. "These three causes, namely: the bile, the poisonous mineral substances, and immature and too strong wines, although so different in appearance, produce, no matter what might say Mr. Tronchin, colics of about the same kind." [Gratch]
15. From the Rhine Valley. [Ed.]
16. Ce qu'il y a de certain, c'est que la colique, don't il est question, a etè eipidemique dans les pays ou l'on boit des vins de Rhin et de lat Moseelle. Ces vins pechent souvent par trop de verdeur; et les Marchands les ont long terms alterè avec la litarge. (Examen d'un livre qui a pour titre T. Tronchin de Colica Pictonum, par un medecin de Paris, p. 7). [Author footnote] Translated as, "What is certain, is that the colic in question was in epidemic state in countries where people drink wines from Rein and Moselle. These wines, quite often, suffer from too much 'green' (verdeur); and the merchants since long time ago used to adulterate the wines with lead. (See 'T. Tronchin de Colica Pictonum, par un medecin de Paris,' p. 7)." [Gratch]
17. Someone with a weak or sickly constitution, especially someone whose chief concern is being or becoming a chronic invalid. [*Webster's New World Medical Dictionary*, 2003]
18. Yellowed. [Ed.]
19. Most likely *primae vitae*, meaning primary or early years. [Ed.]
20. Potassium Hydrogen Tartrate, $KHC_4H_4O_6$ or $C_4H_5KO_6$. [*An Alchemists Glossary of Terms, Definitions, Formulas & Concoctions*, http://www.3rd1000.com/alchemy/alchemyterms.htm]

21. Lead monoxide; a yellowish red substance, obtained as an amorphous powder, or crystallized in fine scales, by heating lead moderately in a current of air or by calcining lead nitrate or carbonate. It is used in making flint glass, in glazing earthenware, in making red lead minium, etc. [*Webster's Unabridged Dictionary*, 1913]
22. "It is known, that in our neighborhood vinegar and wine immature and acid, was used for many years in grand quantity, without any bad effect. The same can be said about our own city. For ten years she [our city?] was free from roughness. After which, with fraud, many coopers and inn-keepers secretly functioned; many others who did not get wine from in-keepers, and did not drink it in their homes, escaped immune from pain and tortures. Some members of family consumed for many years very strong and very acid wine, so that it wouldn't be possible to support a more acid taste; others, preferred somewhat sweet drink, suffered weakness of limbs, many of whom died miserably." [Gratch]
23. "Evidently Nature wanted to produce many acid and astringent herbs against violent and endemic maladies, dysenteries, cholerae, spasms originating from bile: almost indicating with finger wherever such maladies used to occur, in those localities there was in abundance those herbs." [Gratch]
24. "They can be seen in villages, like ghosts or walking statues, pale, miserable, their hands curved, their bodies hanging down, unable to keep straight upper parts of their body; moving their feet not by muscles of the foot but by those of shin, making their deambulation ridiculous and miserable; their voice is noisy and too loud." [Gratch]
25. "Better days (better times?) for strangers acting with integrity." [Gratch]
26. Sugar of lead, lead acetate. Pb(C2H3O2)2.3H20. [*An Alchemists Glossary*]
27. Arsenic (II) sulfide, As_2S_2 or Arsenic (III) Sulfide, As_2S_3. [*An Alchemists Glossary*]
28. Milk of surfur; finely divided white colloidal Sulfur (S) in solution. [*An Alchemists Glossary*]
29. "Tortured the souls of physicians not less than the viscera of the patients." [Gratch]
30. Malaria. [Ed.]
31. Causing sweats. [*Webster's*, 1913]
32. A wasting or consumption of the tissues. The term was formerly applied to many wasting diseases, but is now usually restricted to pulmonary phthisis, or consumption (tuberculosis). [*Webster's*, 1913]
33. Excessive discharge of fluid. [*Webster's*, 1913]
34. Diarrheal diseases. [Ed.]
35. A white lead pigment, sometimes used in cosmetics. [*The American Heritage® Dictionary of the English Language*, 4th ed., 2004]
36. Amounts of the ingredients are given in the original text as old apothecary weights. [Ed.]
37. By spoonfuls. [Ed.]
38. "While thinking of the internal use of lead made by Chinese, one has to believe that they (the Chinese) are of a different constitution, or that their lead is different from ours." [Gratch]
39. "At the beginning chiefly, by frequent bowel movements, but not so coious (abundant?), together with some tightness." [Gratch]

40. "There are many who not only disapprove any presence of constipation, but even complain of diarrhea." [Gratch]
41. "Many, indeed, very many were not affected by it, although they had used it (cyder?) so much to become drunk; others were affected less." [Gratch]

Chapter 5 POTT

1. Since Mr. Pott published this tract, I saw the disease which is described, in an infant under eight years of age, who was brought into St. Bartholomew's hospital, and was an apprentice to a chimney-sweeper. I showed it to Mr. Pott, who acknowledged it to be the true disease, and that he had not before seen it in so young a subject. It had infected all the lower part of the scrotum; but, as the testis had not imbibed the poison, the diseased part being removed, the wound healed, and the boy was discharged perfectly well. E. [Commentary by J. Earle, 1790]

Chapter 6 JENNER

1. The late Mr. John Hunter proved, by experiments, that the Dog is the Wolf in a degenerated state. [Author footnote]
2. Spreading, obstinate ulceration. [*Webster's Unabridged Dictionary*, 1913]
3. They who attend sick cattle in this country find a speedy remedy for stopping the progress of this complaint in those applications which act chemically upon the morbid matter, such as the solutions of the Vitriolum Zinci, the Vitriolum Cupri, &c. [Author footnote]
4. It is necessary to observe, that pustulous sores frequently appear spontaneously on the nipples of Cows, and instances have occurred, though very rarely, of the hands of the servants employed in milking being affected with sores in consequence, and even of their feeling an indisposition from absorption. These pustules are of a much milder nature than those which arise from that contagion which constitutes the true Cow Pox. They are always free from the bluish or livid tint so conspicuous in the pustules in that disease. No erysipelas attends them, nor do they shew any phagedenic disposition as in the other case, but quickly terminate in a scab without creating any apparent disorder in the Cow. This complaint appears at various seasons of the year, but most commonly in the Spring, when the Cows are first taken from their winter food and fed with grass. It is very apt to appear also when they are suckling their young. But this disease is not [to be] considered as similar in any respect to that of which I am treating, as it is incapable of producing any specific effects on the human Constitution. However, it is of the greatest consequence to point it out here, lest the want of discrimination should occasion an idea of security from the infection of the Small-pox, which might prove delusive. [Author footnote]
5. I have purposely selected several cases in which the disease had appeared at a very distant period previous to the experiments made with variolous matter, to shew that the change produced in the constitution is not affected by time. [Author footnote]
6. It is remarkable that variolous matter, when the system is disposed to reject it, should excite inflammation on the part to which it is applied more speedily

than when it produces the Small-pox. Indeed it becomes almost a criterion by which we can determine whether the infection will be received or not. It seems as if a change, which endures through life, had been produced in the action, or disposition to action, in the vessels of the skin; and it is remarkable too, that whether this change has been effected by the Small-pox, or the Cow Pox, that the disposition to sudden cuticular inflammation is the same on the application of variolous matter. [Author footnote]

7. When the Cow Pox has prevailed in the dairy, it has often been communicated to those who have not milked the cows, by the handle of the milk pail. [Author footnote]
8. This is not the case in general—a second attack is commonly very slight, and so, I am informed, it is among the cows. [Author footnote]
9. It is a remarkable fact, and well known to many, that we are frequently foiled in our endeavours to communicate the Small-pox by inoculation to blacksmiths, who in the country are farriers. They often, as in the above instance, either resist the contagion entirely, or have the disease anomalously. Shall we not be able now to account for this on a rational principle? [Author footnote]
10. From the sore on the hand of Sarah Nelmes.—See the preceding case. [Author footnote]
11. A dry crust or scab which separates from the body. [*Webster's*]
12. Perhaps a few touches with a lapis septicus [potassium hydroxide. Ed.] would have proved equally efficacious. [Author footnote]
13. What effect would a similar treatment produce in inoculation for the Small-pox? [Author footnote]
14. It is very easy to procure pus from old sores on the heels of horses. This I have often inserted into scratches made with a lancet, on the sound nipples of cows, and have seen no other effects from it than simple inflammation. [Author footnote]
15. See Case IX. [Author footnote]
16. My friend Dr. Hicks, of Bristol, who during the prevalence of this distemper was resident at Gloucester, and Physician to the Hospital there, (where it was seen soon after its first appearance in this country) had opportunities of making numerous observations upon it, which it is his intention to communicate to the Public. [Author footnote]
17. I have been informed from respectable authority that in Ireland, although dairies abound in many parts of the Island, the disease is entirely unknown. The reason seems obvious. The business of the dairy is conducted by women only. Were the meanest vassal among the men, employed there as a milker at a dairy, he would feel his situation unpleasant beyond all endurance. [Author footnote]
18. A constitutional disease, generally hereditary, especially manifested by chronic enlargement and cheesy degeneration of the lymphatic glands, particularly those of the neck, and marked by a tendency to the development of chronic intractable inflammations of the skin, mucous membrane, bones, joints, and other parts, and by a diminution in the power of resistance to disease or injury and the capacity for recovery. Scrofula is now generally held to be tuberculous in character, and may develop into general or local tuberculosis (consumption). [*Webster's*]
19. See Note in page 7. [Author footnote] See note 4 here. [Ed.]

Chapter 7 PANUM

1. Mr. Regenburg, Provincial Surgeon, who was the cabinetmaker's physician, was ill himself at the same time at which the former's illness was at its height, which, as well as the surgeon could remember, was on April 4th. [Author footnote]
2. This was related correctly. On the 20th of May, one man had been at the trading-place, Klaksvig, where the measles was prevailing, and he broke out with the exanthem on June 3rd; on the 25th of May the two others had been at the same place and the exanthema appeared on them on June 8th. [Author footnote]
3. An outhouse for drying fish. [Translator's footnote]
4. Influenza. [Ed.]

PART II

Chapter 8 FARR

Lecture Introductory to a Course on Hygeine, or the Preservation of The Public Health

1. "To destroy the reason for living for the sake of life itself." [Translated by T. Patrick Hill, Ph.D.]
2. "Every people has its prodigies but the Jewish people itself is a prodigy." [Translated by T. Patrick Hill, Ph.D.]
3. Animal food is so abundant in some parts of South American, in Chile, for instance, that it is not uncommon in that country to kill a large beast for the sake of the single meal of a few pounds weight, which a few travelers can make from certain parts of its carcass, the remainder being left on the plains to appease the hunger and gratify the palates of animals which are less delicate of taste than man, when flesh has been for a few hours exposed to the heat of a climate within the torrid zone. In such a fact the statement of Bruce may have originated.—Ed. L. [Original editorial footnote]
4. Original editorial comment.

On the "Table of Mortality" for the Metropolis

1. In the Table there is a corresponding table for males. [Author footnote]
2. The metropolis, in the Registrar General's Report, includes, besides the parishes which Mr. Rickman classed under that name, Fulham, Hammersmith, Camberwell, St. Mary Stoke Newington, St. Leonard, Bromley, St. Mary-le-Low, and the Greenwich Union (Greenwich, Deptford, Woolwich), containing, in 1831, a population of 121,031; and Mr. Rickman appears to have accidentally omitted Norton Folgate (population 1918,) in his summary of the population of the metropolis.—*Exum. Abstract*, vol. .ii. p. 1060. [Author footnote]
3. The population and area of the several Districts, are given in the Registrar General's Report, "Appendix, P;" pp. 114–15. [Author footnote]

Chapter 9 CHADWICK

Report on the Sanitary Condition of the Labouring Population of Great Britain and On the Means of Its Improvement

1. As Assistant Commissioner, and later Commissioner on the Poor Law Commission, 1933–4. [Author footnote]
2. Extracts from the information received by His Majesty's Commissioners as to the administration and operation of the Poor Laws (1833); Edwin Chadwick, Londone and Bershire; pp. 201–339. [Author footnote]
3. This table is the work of William Farr, Compiler of Abstracts in the Registrar-General's office. It was originally published as App. 1 to the First Report of the Registrar-General (1839). [Author footnote]
4. Neil Arnott & James P. Kay, 'Report on the prevalence of certain physical causes of fever in the Metropolis, which might be removed by proper sanitary measures.' App. A, Supplement 1, to the Fourth Annual Report of the Poor Law Commission (1838), pp. 103–29. [Author footnote]
5. Returns of the Registrar-General for Scotland were first published in 1855. [Author footnote]
6. Robert Cowan's statistics of fever (typhus) in Glasgow showed that the heaviest incidence of the disease was between the ages of 15 and 25. (R. Cowan, 'Vital statistics of Glasgow,' J.R.S.S., III (1840), 276.) [Author footnote]
7. British killed at Waterloo amounted to 2,136. Allied killed and wounded amounted to 36,590, and if allied casualties bore the same proportion to killed as did the British, then the total allied killed must have been in the region of 7,300 (W.B. Hodge, 'On the mortality arising from military operations,' J.R.S.S., XIX (1856), 267). [Author footnote]

Chapter 10 SIMON

1. It seems almost unnecessary to remind the reader that five more years have added infinite additional testimony to that mentioned in the text as existing in 1849; and that, two years ago, in a special Act of Parliament, it was enjoined on the Water Companies of the Metropolis that, within seven years, they should follow the precedent so extensively established. In the face of such evidence—with the knowledge that Manchester has a constant supply and that Glasgow is arranging one, it certainly tests one's credulity to hear it rumoured that our Metropolitan Water-Merchants are hoping to resist that requirement, on the ground that such a supply in London would be *impossible*.—J.S., 1854. [Author footnote]
2. To the philosophical thinker there would seem to exist no important difficulty which would prevent the collective warming of many houses in a district by the distribution of heat from a central furnace—perhaps even so, that each house might receive its *ad libitum* share of ventilation with warmed air. Ingenuity and enterprise, in this country, have accomplished far more arduous tasks; and I little doubt that our next successors will have heat-pipes laid on to their houses, with absence of smoke and immense economy of fuel, on some such general organization as we now enjoy for gas-lighting and water-supply. [Author footnote]

Chapter 11 SHATTUCK

1. Lemuel Shattuck, Nathaniel Banks, Jr. and Jehiel Abbott. [Author footnote]
2. This word is derived from the Latin *sanitas*, meaning "soundness of health." It is sometimes written, erroneously, as we think, sanatory, sanotary, and sanitary. The most correct authors, however, now write, sanitary. *Hygiene* (from a Greek word, derived from Hygeia, the goddess of health, meaning to be well) is defined as "health, the preservation of health, that part of medicine which regards the preservation of health." *Hygiean* and hygienic have the same meaning as sanitary. These words are sometimes used as technical terms, especially by medical men; but we dislike, and see no good reason for substituting them for more simple, proper and comprehensive English words, health and sanitary, which are generally understood. We would divest our subject of all mystery and professional technicalities; and as it concerns every body, we would adapt it to universal comprehension, and universal application. [Author footnote]
3. Dr. Edward Jarvis; Communications, Mass. Medical Society, Vol. VIII, p. 1. [Author footnote]
4. The medical department of the National Institute have said, in the Transactions of the American Medical Association, Vol. I, p. 306, that "they had reasons to know, that the medical profession in this country, as a general rule, has many preconceived prejudices to research, which can alone make its deductions practically useful." We sincerely hope, however, that this prejudice does not extensively exist. [Author footnote]
5. "Report on the Sanitary Condition of the city of London," p. 38, by Dr. John Simon, Officer of Health; presented Nov. 6, 1849. To this valuable report we shall have occasion again to refer. [Author footnote]
6. The valuable Reports of the Commissions, heretofore existing in Massachusetts, are of considerable length. That on *Insects* contains 460 pages; that on *Invertebrata*, 374 pages; that on *Fishes, Reptiles, and Birds*, 416 pages; and that on *Trees and Shrubs*, 547 pages; besides illustrative plates in each. The first of these reports has been ordered to be reprinted this year. It would be reasonable to suppose that MAN was entitled to a consideration equal to either of these subjects. [Author footnote]
7. Towns, however, under the general authority which they possessed, sometimes made regulations regarding sickness. The selectmen of Salem, in 1678, "ordered that William Stacy, who is sick of the small-pox, doth not presume to come abroad till three weeks after this date; and that he be very careful that when the time be expired he shift his clothes, and do not frequent company till he is wholly clear of the infection." And again—"The selectmen being informed that William Lord, Jr., is visited with the small-pox, at his fathers house, do order that William Lord, sen., his wife and children that live with him, do keep within their house, and that they do not offer to sell any of their wares, *viz*.: bread, cakes, gingerbread, and the like; and that they suffer none to come to their house, but what necessity requires, upon the penalty of 208, in money for each offence. It is ordered that Thomas Stacey doth forbear grinding at the mill, and that he be careful he doth not infect others, on the penalty of 208. A house is ordered to be impressed for our sick, having the small-pox."—Felt's Annals of Salem, Vol. II, p. 423.

The following act was passed by the Massachusetts Colony, in 1660:—"This court, considering how far Satan doth prevail upon several persons within this jurisdiction to make away themselves, judgeth that God calls them to bear testimony against such wicked and unnatural practices, that others may be deterred therefrom: Do therefore order, that from henceforth, if any person, inhabitant or stranger, shall at any time be found by any jury to lay violent hand on themselves, or be willfully guilty of their own death, every such person shall be denied the privilege of being buried in the common burying-place of Christians, but shall be buried in some common highway, where the selectmen of the town where such person did inhabit shall appoint, and a cart-load of stones laid upon the grave as a brand of Infamy, and as a warning to others to beware of the like damnable practices." Ancient Charters and Laws, p. 187. [Author footnote]

8. Any infectious disease. [*Stedman's Medical Dictionary*, 27th ed., 2000]
9. A common term for yellow fever. [Ed.]
10. Attendants. [Ed.]
11. Mass. Historical Collection, Vol. I, p. 143; Hutchinson's Hist. Mass., Vol. I, p. 34. [Author footnote]
12. Thatcher's Hist. Plymouth, p. 32. [Author footnote]
13. Webster, V01.1, p. 187. [Author footnote]
14. Winthrop's Journal, II, p. 310. [Author footnote]
15. Felt: Annals of Salem, Vol. II, p. 413. [Author footnote]
16. Webster, Vol. I, p. 203. [Author footnote]
17. Webster, I, p. 216. [Author footnote]
18. Ibid, I, p. 224. [Author footnote]
19. Shattuck's History of Concord, p. 223. [Author footnote]
20. History of Danvers, p. 42. [Author footnote]
21. Those who may wish to investigate this curious subject are referred to a volume of these pamphlets, preserved in the library of the Massachusetts Historical Society; and to Thatcher's American Medical Biography, Vol. I, pp. 20, 185, 255, where will be found notices of Drs. Boylston and Douglass.

    Douglass had his prejudices and eccentricities. In his "Summary," published in 1753, (II, p.351) he wrote as follows, of the medical profession:—"In general, the physical practice in our colonies is so perniciously bad, that excepting in surgery, and some very acute cases, it is better to let nature, under a proper regimen, take her course, than to trust to the honesty and sagacity of the practitioner: our American practitioners are so rash and officious, the saying in the *Apocrypha* (38 and 15) may with much propriety be applied to them—'*He that sinneth before his Maker, let him fall into the hands of the physician!*'

    Frequently, there is more danger from the physicians than from the distemper. Our practitioners deal much in quackery and quackish medicines, as requiring no labor of thought or composition, and highly recommended in London quack bills, (in which all the reading of many of our practitioners consists) in advertently encouraged by patents for the benefit of certain fees to some offices, but to the very great damage of the subject." "In most trifling cases they use a routine practice. When I first arrived in New England, I asked a most noted facetious practitioner what was their general method of practice; he told me their practice was very uniform: bleeding, vomiting, blistering, purging, anodynes &c.; if the illness continued, there was *repetendi*, and finally *muderandi*; nature was never to be consulted, or allowed to have any concern in the affair. What Sydenham well observes is the case with our practitioners: Aeger nimia medici diligentia ad plures migrat." [Author footnote] Translated as: "The sick person moves more often from one place to another according to the attentiveness of the physician." [T. Patrick Hill, Ph.D.]

22. Illnesses with vomiting fever and sometimes jaundice (typhoid, malaria, typhus or hepatitis). [Ed.]
23. Webster, Vol. I, p. 252. [Author footnote]
24. Communications, Massachusetts Medical Society, Vol. II, p. 482. [Author footnote]
25. Communications, Massachusetts Medical Society, Vol. II, p. 445. [Author footnote]
26. The sanitary expenses of the city of Boston, for 1832, were:—

For Internal Health Department	$21,610.67
For External Health and Quarantine Establishment	5,222.95
For Special Measures against the Cholera, about	23,600.00
Total	$50,433.62

Boston Medical Journal, Vol. 9, p. 209. [Author footnote]

27. This and several other medical terms will be explained in the appendix. [Author footnote] [Appendixes not included. Ed.]
28. American Journal of Medical Sciences, Vol. I, for 1841, p. 382. [Author footnote]
29. The purpose of this report will not admit of so full an explanation and illustration of these several classes of facts, nor of the plan obtaining them and of making the abstracts for publication, as may be necessary to make them clearly understood. Those who desire further information on the subject, are referred to a report on the state census of Massachusetts, (House document No. 127 for 1849); to the Instructions issued for taking the seventh census of the United States; to the Report on the Census and Statistics of Boston for 1845; to an article in the Journal of the Statistical Society of London, on the Best Mode of taking the census of the United Kingdom for 1841, Vol. III, p. 72, for April, 1840; to the three volumes of Abstracts of that Census, Published under the titles of the Enumeration Abstract, Occupation Abstract, and Age Abstract; to the admirable but voluminous Report of the Commissioners for taking the Census of Ireland for 1841; to the series of Reports of the Registrar General of Births, deaths and marriages in England, and especially to the Appendices to the Ninth Annual Report, and to the "Recensement General"—the General Census of Belgium for 1846,—a work admirably executed, under the central Statistical Commission, of which M. Quetelet is President. These works contain the results of the more recent experience, and should be carefully studied by all who may have the superintendence of the census. [Author footnote]
30. Dr. Simon's Report, p. 19. [Author footnote]

31. Liverpool Health of Towns Advocate, p. 99. [Author footnote]
32. The following are the provisions of an act relating to public hygiene, passed April 24, 1850:

    SECT.1. Physiology and hygiene shall hereafter be taught in all the public schools of this Commonwealth, in all cases in which the school committee shall deem it expedient.
    SECT.2. All school teachers shall hereafter be examined in their knowledge of the elementary principles of physiology and hygiene, and their ability to give instructions in the same.
    SECT.3 This act shall take effect on and after the first day of October, one thousand eight hundred fifty-one. [Author footnote]

33. The Introduction to the Statistical Reports on the Health of the Navy, already referred to, (p. 37) and the Reports to the General Board of Health of England on Quarantine, contain many very valuable suggestions on this subject, to which we refer those interested. We extract from the latter work (pp. 115–118) an account of one regulation, which has had great influence:—

> "It is stated that when the system of transpiration was first adopted, in some of the earlier voyages full one-half of those who embarked, later, on the passage to New South Wales, as in the Hillsborough, out of 306 who embarked, 100 were lost" and in another ship, the Atlas, out of 175 embarked, 61 were lost. Yet there were no omissions palpable to common observation, or which could be distinctly proved as matter of crimination, to which responsibility might be attached. The shippers were no doubt honorable men, chargeable with no conscious designs against the lives of the human beings committed to their care, and with no unusual omissions; but their thoughts were directed by their interests exclusively to profits: they got as much freight as they could, and they saw no reason why convicts or emigrants should not put up with temporary inconveniences to make room for cargo.
>
> "By a simple change, (based on the principle of self interest, the most uniform, general, and, when properly directed, really beneficent of all principles of action) by the short alteration of the terms of the contract, so as to apply the motive where alone there was the effectual means of prevention, by engaging to pay only for those landed alive, instead of paying for all those embarked,—these extreme horrors were arrested, the generation of extensively mortal epidemics was in a short time prevented, and clean bills of health might have been given to all the ships which before would have been entitled to none. From the Report of the Select Committee on Transportation, in the year 1812, it appears that in one subsequent period,—namely, from 1795 to 1801,—out of 3,833 convicts embarked, 385 died, being nearly one in ten. But since 1801, after the principle of responsibility began to be applied, out of 2398 embarked, only to one and a half per cent., or even lower than the average mortality of such a class living shore. The shippers themselves, without any legislative provisions, or any official supervision or regulations thereto, appointed medical officers, or surgeons, and put the whole of the convicts

under their charge; the shippers attested their own sense of the propriety, sound policy, and efficiency of the principle, by voluntarily adopting it, and applying it to each ship-surgeon in charge, whose remuneration was made dependent on the number of passengers landed alive.

"The alteration, stimulated by the self—interest of the ship-surgeons or officers engaged in that service, led to highly important practical results as to the means of securing health and preventing disease. In the course of the sanitary inquiries which have served as the basis of legislation, a surgeon who had the charge of transport ships described the toils of his service during long voyages, his sleeplessness on stormy nights, his getting out of his hammock to see that the wearied sailors, whom he would not trust to themselves, took off their wet clothes and put on a proper change before they turned in; and he narrates how he was complimented on his sentiments of active benevolence, when he frankly owned that he was really only entitled to praise for vigilance to his own interests. Some benevolent and intelligent ship-owner had taken care that the sailors as well as the passengers should be included in his contract for remuneration. He acknowledged it was that which kept his thoughts intent on the means of preserving their health, as well as saving his own trouble in merely treating illness when it occurred, which alone, in consequence of a vicious short-sightedness, is ordinarily considered the surgeon's sole duty, and not that of a giving general advice or directions for the preservation of health.

"In cases of contracts on these terms for the transport of troops, where the officers in command had forgotten to provide surgeons for their care, the pecuniarily responsible shippers had not failed to provide them.

"The same principle of pecuniary responsibility has also been partially applied to the transport of pauper emigrants, with complete success, as far as the experiment has been made; affording a result which stands out in strong contrast with the horrible events on board vessels where this has not been applied.

"There is strong reason to believe, from recent experience, that the general adoption of this principle in its full extent would do more to meet the formidable difficulties of these emigration ships, than the best devised system of inspection in the absence of this principle." [Author footnote]

34. Dempsey's Drainage and Sewage of Towns and Buildings, pp. 4, 5, and 20. [Author footnote]
35. Dr. Jarvis's Address, Communications Mass. Med. Soc., p. 4. [Author footnote]
36. British and Foreign Medico-Chirurgical Review, Vol. II, for October, 1848, pp. 509, 510. [Author footnote]
37. Mann's Sixth Annual Report, pp. 84, 85, 88, 89, 97. [Author footnote]
38. Edinburgh Review, Vol. XCI, January, 1800, p. 212. [Author footnote]
39. Do. for April, 1850, p. 389. [Author footnote]
40. We extract from the Report on the Condition of Large Towns, the following illustrative passage from the testimony or Dr. Taylor, an intelligent surgeon of

London:—"Amongst others was the family of a policeman whom I attended. When he applied for relief, the observation which occurred was, 'You have, as a policeman, 20s. a week regular wages, and other advantages; you are never out of work, and cannot be considered a proper object of relief from the funds of a dispensary intended for the poorest class?' His reply was that he paid for his miserable one room, divided into two, 5s. a week; that he had 1s. 8d. weekly to pay for keeping up his clothes, which reduced the money he had for his family of four children and his wife to 13s. 4d.; that he had had all his children ill, and lost two; that he had during three years paid six doctors' bills, principally for medicine, at the rate of 2s. 6d. a bottle, amounting to between £30 and £40; that two of the children had died, the funerals of which, performed in the cheapest manner he could get it done, had cost him £7: the wife and his four children were now ill. They were so depressed and debilitated, as to render them very great objects for the dispensary and the Samaritan Fund. All his misery was traceable to preventable causes. Take another case in the list before me. A porter, in regular employment, at wages producing £1 a week: he paid 3s. 6d. for a most miserable and unwholesome room, in which himself and six other people, four children and three adults, slept; the children were shoeless, extremely filthy, and badly clad; the wife ill in bed of a diseased knee, for while I attended her; two children had been still-born, and he had lost three others; the sickness of one of these children, which had died at fourteen of consumption, had cost him in doctors' bills 16 guineas; the sickness of the one which died eleven months old, of water on the brain, had cost him £6; the third had died fourteen days old. The expenses in the three cases had so impoverished him, that he was compelled to apply to the parish for aid for their burial. I will submit a third case—that of a cook, in receipt of 25s. per week regular wages. He was living with his wife and three children in a small, close, ill-conditioned room, for which he paid 5s. per week rent. He complained that the water was always 'thick,' and very disagreeable to the taste, and the smells from the sewers and the drains in the house were very bad: he had five children, of whom two had died; that he had paid doctors' bills for his wife's confinements £5 each; and for one child which died of scarlet fever, at four years of age, the doctor's bill was £4, 18s.; the one which died of debility at the age of ten weeks, cost him £1, 10s.; the funeral of the eldest child cost him £3; and the one at the age of ten weeks, £1, 10s. He showed that the expenses of confinements, the doctors' bills, and the unndertakers' bills, and the illness of his wife, arising from five miscarriages, had so impoverished him, that having now two children ill with scrofula, he was obliged, though reluctantly, to apply to the dispensary for relief. The last case I will submit to the commissioners is that of a shoemaker, a good workman, who earns 20s. a week: he pays 5s. a week for one small, miserable room, in a narrow court; he has had seven children, of whom he has lost five, for which he has paid in doctors' bills between £2 and £3 each; his wife's age was thirty two, his own age thirty-seven, and at this age of thirty-seven he continually suffered from nervous depression; and having one of his two other children with a lingering disease—a scrofulous affection of the hip—he was compelled to come to the dispensary; he complained that the water of his house was never clear and never sweet. A man in receipt of 30s. per week's wages, considering his amount of rent which was 5s. 6d. for one room, for himself, wife, and three children; having had four deaths after lingering consumptions, and a wife and children never well, I felt that he also was a proper object of the charity. At the time I visited these 100 families, no less than 212 of the members were suffering under disease manifest in various stages. They had already had no less than 251 deaths and funerals, and a corresponding amount of sickness. It was only in a late stage of my investigations that I began to see the very serious amount of miscarriages they have had, and which in many instances exceed the deaths. Three hundred and fifty of the members of these 100 families were dependent children, whose average age was little more that ten years."

Henry Austin, Esq., in his Report on the Sanitary Condition of Worcester, (p. 40) says the attacks of fever appear to commit the greatest ravages among those in the vigor of life; and to one fatal case there is at least 10 attacks. "An insurance charge for the mitigation of the effects of sickness and premature mortality for an average family, is more than three times the annual cost of the outlay for the whole of the intended works at Worcester," sufficient to place the city in a good sanitary condition. [Author footnote]

41. After the above was written, and while this sheet was passing through the press, the able notice of Edwin Chadwick, Esq., the distinguished sanitary reformer, in the North British Review, for May, 1850, arrested our attention. We extract from page 26, (Am. Ed.) the following passage, coinciding with the views we have expressed:—"The principle, though apparently so simple that no one could miss it, is in reality a discovery. It may be stated thus:—In every case of social wrong that it is desired to remedy, get at the antecedents, and apply the legislative or administrative interference at that point or at those points, in the chain of antecedents, where such interference may be either most easy or most radical and effective. These phases, Get at the antecedents, Mount to the sources, appear to be stereotyped maxims in the mind of Chadwick—secrets in his mode of dealing with all questions of social disease whatever. Whether it is into the means of preventing crime that he inquires, or into the means of preventing pauperism, or lastly, as he has more than once proposed, into the means of preventing insanity, his method is still the same; namely, by a rigorous examination of numerous individual cases, to ascertain the most common antecedents of the evil under notice, and out of these antecedents to select that one or those few, on which rap of legislative enactment or an administrative precaution may most easily and surely come down. Even in cases of what seems inevitable and hopeless evil, at which society must just gaze with pity and shake its head, he has commonly found that a little inquiry will reveal at least one antecedent that may be destroyed, one source that may be dried up. Thus as regards lunacy, it is his firm belief, announced more that once in his more recent communications with the public, that were all the cases of lunacy in the country to be undertaken by the state in such a manner that the antecedents in each case should be rigorously traced out, causes of that fearful malady would be expiscated perfectly within the range of general regulation and statute." [Author footnote]
42. Mr. Chadwick, in his report, says of such scenes in England, "The corpse is never absent from the sight of the survivors; eating, drinking or sleeping, it is there." (See Sanitary Movement, p. 13.) [Author footnote]
43. "Of all the great undertakings by which the era is signalized, there is perhaps none which so clearly stamps a character of real and essential progress as the

Sanitary Movement; for the result of this, mediate and immediate, is a positive, a cumulative good; a social, moral, and intellectual amelioration of a most beneficial nature,—one which we believe is destined to effect great results in the material advancement of a people. Its ultimate effect whether so intended or not, lies beyond the pecuniary advantage—the dollars and cents; it recognizes the existence of claims and sympathies intimate relations between all phases and grades of society."—Chambers' Papers for the People, No. 9, p. 1. [Author footnote]

44. The opponents of the sanitary movement in England, in its incipient stages, represented London as the most healthy city in the world; and yet its condition has justified the following statement:—"About two millions of inhabitants are contained in the metropolis, or about the Kingdom. Of this number, according to the Registrar-General's statement for 1844, 50423 die annually, or 1 in 39. But if the rate of mortality were 1 in 50, in place of 1 in 39, as it is in several large towns of England, and in the healthier parts of the metropolis itself, there would be an annual savings of 10278 lives. In the metropolis, there are about 266 deaths every week, nearly 38 deaths a day, or considerably more than one every hour, over and above what ought to happen in the common course of nature.

    Now, it has been calculated that, for every death which takes place, there are 28 cases of sickness which do not end fatally. We have, therefore, 387296 cases of sickness occurring in the metropolis every year, which are unnecessary and preventable. 13832 lives could be saved,—more than a third of a million of cases of sickness could be prevented. One-fifth of the total waste of health and life which takes place in the United Kingdom occurs in the metropolis. Of the 49089 persons who died in London in the year 1846, 22275 died before they reached the 15th year of their age, and only 2241 of old age, which the illustrious Boerhaave stated to be the only disease natural to man."—Journal of Public Health, vol. ii. p. 225. [Author footnote]

45. The following description of the water used by the citizens of London, is from the Edinburgh Review, (April, 1850, p.381): "The refuse and dirt from two millions of individuals, and offal of slaughter-houses,—the outpourings from gasworks, dye-works, breweries, distilleries, glue-works, bone-works, tanneries, chemical and other works,—and a thousand wards and forwards by the tide, and, having been thoroughly stirred up and finely comminuted [*sic*] by the unceasing splash of 298 steamboats, is then pumped for the use of the wealthiest city in the world!" And yet a city which depends upon such water for its domestic use is as healthy as Boston! [Author footnote]

46. Liverpool Health of Towns Advocate, p. 87. [Author footnote]

47. Edinburgh Review, January, 1850, p. 213. [Author footnote]

48. Ibid. 214, 215. [Author footnote]

49. See Pickering's Reports, Vol. VII; p. 76; and Vol. XII, p. 184. We extract one of these decisions. "It is not only the right but the duty of the city government of Boston, so as they may be able, to remove every nuisance which may endanger the health of the citizens. And they have necessarily the power of deciding in what manner this shall be done, and their decision is conclusive, unless they transcend the powers conferred on them by the city charter. Police regulations to direct the use of private property so as to prevent its being

pernicious to the citizens at large, are not void, although they may in some measure interfere with private rights without providing for compensation. The property of a private individual may be appropriated to public uses in connection with measures of municipal regulations, and in such case compensation must be provided for, or the appropriation will be unconstitutional and void." [Author footnote]

50. "So indispensable an element is health in all forms of human welfare, that whoever, invigorates his health has already obtained one of the great guaranties of mental superiority of usefulness, and of virtue. Health, strength, and longevity, depend upon immutable laws. There is no chance about them. There is no arbitrary interference of higher powers with them. Primarily our parents, and secondarily ourselves, are responsible for them. The providence of God is no more responsible, because the virulence of disease rises above the power of all therapeutics, or because one quarter part of the human race die before completing the age of one year,—die before completing one seventieth part of the term of existence allotted to them by the Psalmist;—I say the providence of God is no more responsible for these things, than it is for picking pockets or stealing horses."

"Health is earned,—as literally so as any commodity in the market. Health can be accumulated, invested, made to yield its interest and its compound interest, and thus be doubled and redoubled. The capital of health, indeed, may all be forfeited by one physical misdemeanor, as a rich man may sink all his property in one bad speculation; but it is as capable of being increased as any other kind or capital; and it can be safely insured on payment of the reasonable premium of temperance and forethought. This, too, is a species of wealth, which is not only capable of a life-long enjoyment by its possessor, but it may be transmitted to children by a will and testament that no human judicature can set aside." "Let the young man, then, remember, that, for every offence which he commits against the laws of health, nature will bring him into judgment. However graciously God may deal with the heart, all our experience proves that He never pardons stomach, muscles, legs, or brain. These must expiate their offences un-vicariously. Nay, there are numerous and obvious cases of violated physical laws where Nature, with all her diligence and severity, seems unable to scourge the offender enough during his life-time, and so she goes on plying her scourge upon his children and his children's children after him, even to the third and fourth generation. The punishment is entailed on posterity; nor human law, nor human device, can break the entailment. And in these hereditary inflictions, nature abhors alike the primogeniture laws of England and the Salic laws of France. All the sons and all the daughters are made inheritors; not in aliquot parts; but, by a kind of malignant multiplication in the distemper, each inherits the whole."—Mann's Thoughts for a Young Man, pp. 14, 23, 19. [Author footnote]

51. British and Foreign Medico-Chirurgical Review, Vol. I, for 1848, p. 32. [Author footnote]
52. Journal of Public Health, V01.1, p. 23. [Author footnote]
53. Quarterly Return, Registrar General, April, 1849, p. 1. [Author footnote]
54. Niles's Register, Vol. XXXVIII, for July 31, 1830, p. 399. American Almanac, Vol. I, p. 187; Vol. II, p. 112. [Author footnote]

Chapter 12 SNOW

1. Report on the Epidemic Cholera, 1824 (p. 5). [Author footnote]
2. See "London Journal of Medicine," May, 1849. [Author footnote]
3. London Journal of Medicine, loc. cit. [Author footnote]
4. In the so-called secondary fever there is toxicohaemia, arising from suppressed excretion by the kidneys. [Author footnote]
5. See "London Gazette," 18th Sept. 1849. [Author footnote]
6. See Report in "Med. Gaz.," vol. ii, 1849 (p. 429). [Author footnote]
7. Edin. Med. and Sur. Journ., vol. xxxvii. [Author footnote]
8. A native of India employed by a soldier by a foreign power. [*American Heritage® Dictionary of the English Language,* 4th ed., 2000]
9. Scot, "Report on the Epidemic Cholera" (p. 237). [Author footnote]
10. The particulars of each death connected with this outbreak were published in the "Weekly Returns" of the Registrar-General to 16th September, and I procured the remainder through the kindness of the Registrar-General and the District Registrars. [Author footnote]
11. The deaths are obtained from the "First Report of the Metropolitan Sanitary Commission," 1847; and the water-supply, chiefly from a work entitled "Hydraulia," by William Matthews, 1835. [Author footnote]
12. A Microscopic Examination of the Water supplied to London. London: 1850. [Author footnote]
13. P. 207. In the table at page 206, Dr. Baly has fallen into the mistake of supposing that the Lambeth Water Company obtained their supply from Thames Ditton in 1849. It was not till 1852 that their works were removed to that place. Dr. Baly has also mistaken the name and identity of all the three Companies which supply the south districts of London with water. [Author footnote]
14. Weekly Return, Oct. 14 (p. 433). [Author footnote]
15. In 1849, there were forty-eight deaths from cholera in Millbank prison, amounting to 43 per cent. of the average number prisoners. In Tothill Fields prison there were thirteen deaths among eight hundred prisoners, or 16 per cent. The other prisons on the north side of the Thames are supplied either by the New River Company, or from pump-wells, and there was but one death from cholera in all of them; that death took place in Newgate. [Author footnote]
16. Report by the Government Commission on the Chemical Quality of the Supply of Water to the Metropolis (p. 177). [Author footnote]
17. Medical Gazette, vol. XIIV (p. 749). [Author footnote]
18. History of the Cholera in Exeter in 1832. [Author footnote]
19. Report of the General Board of Health on the supply of Water to the Metropolis, 1850 (p. 55). [Author footnote]
20. See Report of Commissioners on the Cholera at Newcastle, etc. (p. 474). [Author footnote]
21. Opus cit. (p. xxv). [Author footnote]
22. Report of Swedish Commissioners, quoted in the Second Report of the Metropolitan Sanitary Commission, 1848. [Author footnote]
23. Medical Times and Gazette, Lancet, and Association Journal. [Author footnote]

24. Various conditions are requisite for the production of a disease, as they are for the production of a crop of wheat or turnips; but it is not necessary to dignify these conditions with the name of causes. [Author footnote]
25. Medical Times and Gazette, 1854, vol. I (p. 182). [Author footnote]
26. Cholera, with Reference to the Geological Theory. Cincinnati, 1850. [Author footnote]
27. Composed of or containing or resembling calcium carbonate or calcite or chalk. [*Webster's*]
28. Sandy or consisting largely of sand; of the nature of sand; easily disintegrating into sand; friable; as, *arenaceous* limestone. [*Webster's Unabridged Dictionary*, 1913]
29. Trans. of Roy. Med. and Chir. Soc., 1844. [Author footnote]
30. Med. Times and Gazette, Nov. 25th, 1854. [Author footnote]
31. Report on the Cholera of 1848–49 (p. xl). [Author footnote]
32. Rolle's Account of the Burning of London in 1666. [Author footnote]
33. Official Reports on the Province of Kumaon, by J. H. Batten, Esq., C.E. Agra, 1851. [Author footnote]
34. Dr. Cheyne on Dysentery, Dublin Hospital Reports, vol. iii. [Author footnote]
35. Statistical Reports on the Health of the Navy. Part II. 1853. [Author footnote]
36. See Clinical Report of Continued Feveral, by Austin Flint, M.D.: Buffalo, 1852 (p. 380). Also Med. Times and Gazette, March 12, 1853 (p. 261). [Author footnote]
37. Association Journal, October 6, 1854. [Author footnote]
38. 8 vol., 1842 (p. 66). [Author footnote]
39. Essai de Géographie Médicale (p. 52). [Author footnote]
40. P. 94. [Author footnote]
41. De Aere, Aquis, et Locis. [Author footnote] Translated as "Concerning air, water, and location." [T. Patrick Hill, Ph.D.]

Chapter 13 JARVIS

1. Senate Document No. 9, 1849, pages 6, 7. [Author footnote]
2. Report of Metropolitan Commission on Lunacy for 1844, page 182. [Author footnote]
3. The reports of five American hospitals show that the average time required for the recovery of the patients who had been deranged less than one year, was about five and a half months, and for all patients a little less than seven months. See Appendix A. [Author footnote] [Not reprinted here. Ed.]

Chapter 14 BUDD

1. Letter from the Poor Law Commissioners to the Metropolitan Board of Guardians, November 1840. A certain proportion of these cases were probably cases of *typhus*. But what proportion cannot now be told, as, at that time, save by a few scientific men, *typhoid* and *typhus* were confounded with one another, and registered as one disease. Both, as being much more fatal to adults than to young persons, may be described as specially pauperising fevers. [Author footnote]

2. It is but just to add, that by its untiring efforts to show how vast is the amount of preventable disease suffered to prevail among us, and how great the danger it presents to the future of our race, this Board did much to awaken the minds of the people and the Government to the national importance of Sanitary Reform, and to give to the question the prominence it has since assumed. And there is no denying that in fixing attention on defective drainage, as the chief of sanitary evils its members were guided by a true instinct, however widely they may have erred in their scientific interpretation of the facts. [Author footnote]
3. "Is typhoid contagious? The answer to this question is found in the facts science possesses; and it is sufficient for me to recall some of these to convince the reader." [Translated by T. Patrick Hill, Ph.D.]
4. "I will use the word contagion with its most understood meaning, designating under that name every transmission of the disease from a sick person to a healthy person, which may be the mode by which it is brought about." [Hill]
5. The most important of these particulars were kindly furnished to me by Mr. Brutton, surgeon at Morchard, who had the charge of this group of cases. By a very natural figure of speech, the fever from which all these persons suffered was known amongst the Morchard people as the 'North Tawton' fever. [Author footnote]
6. It is worth noting, that after the fever showed such a strong tendency to spread, Elizabeth and John, with two other members of the family, were sent away to Stocklands, an outlying farm, about two miles off. Elizabeth was seized three days after her removal, but John remained well ten days longer. [Author footnote]
7. See 'Archives générales de la Médecine,' 1st series, vol. xxi. p. 62. [Author footnote]
8. 'Leçons de Clinique médicale,' p. 333. [Author footnote]
9. See 'Recherches, &c., sur la Maladie connue sous les noms de Fièvre typhoïde, &c.,' vol. ii. pp. 371, 516. 1st Edition. [Author footnote]
10. See 'Achives génerales de la Médecine.' 1st Series. vol. xx. p. 372. The epidemics referred to occurred in 1820 and 1828. [Author footnote]
11. "It is necessary to consider this lesion not only as peculiar to typhoid but as forming its anatomical character in the same way as the tubercular lesions form the character of consumption." [Hill]
12. For the ten years during which I lectured on the Practice of Physic at the Bristol Medical School, I always taught this doctrine on the grounds advanced in the text. It was not until the summer of 1857 that I first became aware that M. Bretonneau had put forward the same view in a paper entitled, 'Notice sur la Contagion de la Dothinenterie,' and which was read to the French Academy of Medicine so long ago as July 7, 1829. In that paper M. Bretonneau contents himself with a bare enunciation of the doctrine, and does not enter into any considerations in support of it. Having been unable to obtain a sight of his monograph on Fever, I do not know whether or not he has given more development to the subject in that word. It is obvious enough, however, that the idea that the intestinal affection is a true eruption had been very clearly apprehended by him, so that whatever credit may be supposed to attach to it belongs to him. At the same time he does not appear to have perceived its all important bearing on the mode in which this fever is disseminated. Neither in

his own papers nor in those of Gendron de l'Eure, who in the matter of typhoid fever may be looked upon as his disciple, is there the slightest hint either of the part which the discharges play in the work of propagation, or of the need of measures to disarm these discharges of their contagious power. Cruveilier speaks of the intestinal affection having been compared to an eruption, but refers to the notion as being altogether fanciful and unworthy of serious notice. The reader will find M. Brentonneau's paper in the 'Archives générales de Médecine,' tome xxi. 1829. [Author footnote]

13. The ulcers which sometimes occur in the stomach, in the gullet, and about the epiglottis, are also preceded by, and originate in, a deposit of the same yellow stuff. I believe the same to be the case with the ulcerations which now and then occur in the bladder, and of which I have seen several examples. When pneumonia comes on in the course of the fever, Rokitansky states that the same deposit is found in considerable bulk in the parenchyma of the lung, and also in the bronchial glands. Rokitansky's general statement is, that wherever the chief stress of the specific agent which causes fever falls, there the yellow matter also most abounds. Assuming the fact to be so, it would only establish, on a still wider basis, the close relation which subsists between the yellow matter and the specific poison. [Author footnote]
14. See 'Recherches sur la Fièvre typhoïde,' tome i. pp. 438–39. [Author footnote]
15. It is hardly necessary to observe that in some cases the diarrhoea is slight, and in some few others is absent throughout. In the cases which formed the basis of Louis' great monograph, this last fact was observed in three out of ninety-four cases, or, on an average, about once in thirty times. [Author footnote]
16. See 'Second Report of the Medical Officer of the Privy Council,' article 'Windsor,' and a Paper 'On the Causes of Continued Fevers, with special reference to the Windsor Epidemic,' by Dr. Murchison, read before the Epidemiological Society, on February 9, 1859.

I subjoin in its entirety the abridged account which Dr. Murchison afterwards published in his book on Continued Fevers. 'In the autumn of 1858, an epidemic of enteric fever occurred at Windsor which was made the object of special inquiry by the medical officer of the Privy Council, and an account of which, founded on my own investigations, was communicated to the Epidemiological Society. It was calculated that during the last four months of the year, 440 persons, or about one-twentieth of the entire population, were attacked, of whom thirty-nine died. The characters of the fever were well marked: such as a red, fissured tongue, abnormal pain, tympanitis, diarrhoea, hemorrhages, an eruption of lenticular rose spots, and a duration of three or four weeks. That the fever was due to the emanations from the sewers was the undisputed opinion of all who investigated the circumstances. Most of the cases, and all but one of the fatal cases were confined to two of the three districts of the town, the low level and high level districts. Both of these districts had a complete system of drainage, with water closets within the houses, and sinks in the basements and kitchens. The drains in these two districts were flushed, partly by a continuous flow of water through them from the Thames, and partly from artificial tanks. But, in consequence of a long-continued drought, the Thames had greatly fallen in its level, while the tanks had from neglect been allowed to get dry. The result was that the sewage accumulated in the sewers, and in consequence of their ventilation being very imperfect, the sewer gases escaped directly into the houses. In the two districts mentioned, the fever attacked the rich and poor indeterminately but the cases were most numerous and severe in that part of the low level district where all the drains of the town converged, and where they had the least inclination, that is, at the foot of Sheet Street, near the Barracks.

The inhabitants in these districts complained of the offensive smells from the drains in their house and particularly in the houses where the fever occurred. The district of the town which remained almost exempt from the fever was the worst and poorest, where cholera had raged with the greatest severity in 1849. Although the drains of this district also suffered from want of water, the water closets were almost invariably outside the houses, and there was no communication by sinks or otherwise, between the drains and the interior of the house. With few exceptions, bad smells were not complained of in this district. One woman, however, complained bitterly of the offensive smell from the gully opposite her door: her daughter had died of fever. No case of fever occurred in Windsor Castle; which, as may be seen from the annexed woodcut (not reproduced here) had a drain of its own, unconnected with the town drainage. This drain was well ventilated, and was flushed every morning by a special supply of water. A few of the houses in the Royal Mews participated in this exemption; but in the remainder of the mews, only separated by a roadway from the more favoured portion, but connected with the town drainage, there were thirty cases and three deaths. Lastly, a few cases of fever occurred in the collegiate residences of the Castle, which were also connected with the town drainage.' Dr. Murchison on 'Continued Fever, Pythogenic or Enteric Fever,' p. 446. [Author footnote]

17. In the 'Medical Times and Gazette' for July 2, 1859, this epidemic is made, by the editor, the subject of the following remarks:—

    'The epidemic of typhoid fever at Windsor is subsiding. It should be known that the disease is the true *endemic* typhoid, not the contagious epidemic *typhus.* Mr. Simon made out very satisfactorily that the cases supposed to prove the importation of the disease and its contagious nature, were really cases of scarlatina, which prevailed to some extent during the prevalence of typhoid. So much confusion is kept up by the similarity of the terms 'typhus' and 'typhoid' that it might be well, in default of a better term, to adopt Dr. Murchison's suggestion, and call typhoid 'pythogenetic' fever, especially as its dependence upon the poison generated by putrescent animal matter is becoming so generally acknowledged. At Windsor, its dependence upon the poisonous gases formed in the town sewers was most evident.' [Author footnote]
18. Although, for already given in the preface, I was, myself, slow to perceive this, the position appears to me, now, to be quite unassailable. [Author footnote]
19. Some months after the occurrence of this great calamity, the sanitary defects of the hotel were investigated and remedied; and, as regards these important conditions, the hotel is now, I believe, thoroughly well appointed. [Author footnote]
20. Of the inmates of the hotel itself, the landlady had fever severely, and some other members of the household had, I believe, slighter attacks. But I do not possess any evidence to enable me to give, with precision, the number of local sufferers. [Author footnote]

21. 'M. Gendron,' M. Piedvache observes, 'and all those who have written on the contagion of typhoid fever, have remarked that it is at an advanced period that it principally manifests its contagious properties. In all the cases I have seen, and notably in those I have cited, the first patient had reached an advanced period of the fever when it attacked those about him. In some cases he was entering on convalescence or had been already five or six weeks ill. Most frequently, of all, he was in the fourth week of the disorder rarely in the third.' This corresponds very closely with my own experience. But as the latent period of typhoid fever lasts on an average some twelve or fourteen days, we must go back by that much from the actual onset of the fever to find the true date of infection. These observations apply, however, only to those cases in which the fever germ is received through the air. When it is introduced through the drinking water, the latent period is, as I have shown, often much shorter and the events succeed one another with greater rapidity in the same proportion. [Author footnote]
22. There was, it is true, one important difference between the two cases. Where the stream came into contact with the fever-stricken houses it was an open ditch: where it came into contact with the higher group of house it was a covered drain. But, on the other hand, almost immediately below these last, it passed uncovered through two long fields. In one of these two, a field used as a market garden, a large open catch-pit had existed for many years for storing the sewage of the stream, and from this fetid pool, at the very time the fever was prevailing, numbers of persons were continually dipping, with entire impunity, the liquid sewage in order to water the land with it. [Author footnote]
23. Seats. [Ed.]
24. Case of typhoid fever, with unusually severe cerebral symptoms in the beginning. Recovery. Clinical remarks on the case, and on elimination in the course of this disease, and on the propriety of checking or favouring the diarrhoea. [Author footnote]
25. This hypothesis is founded on the well-known experiments by Thiersch and Pettenkofer on the effects produced on mice by feeding them with cholera discharges. When these discharges were given in the fresh state, the animals suffered no harms but, allowed to putrefy first, the mice fell into a state of collapse and speedily died. These experiments would be quite decisive, if it were proved that what the mice died of was real Asiatic cholera. To complete the proof, it would have been necessary to show that the mice thus poisoned had the power to communicate cholera to other mice in the same way in which cholera-stricken men communicate cholera to other men. But this fundamental piece of evidence is precisely what is wanting. On the other hand, there are very strong reasons for believing that mice are not susceptible of cholera at all. Certainly the rat, the congener of the mouse, is proof against it. In Paris in 1849, the sewers were flooded with rice-water discharges to an enormous extent for months altogether. The rats, which people the sewers of that city so thickly, must have lived during the whole of that time immersed, so to speak, in these excreta. Yet, I believe, no dead rats were seen at the mouths of the sewers, which surely could not have been the case had these animals been subject to the pestilence. At the annual 'Chasse aux Rats' which followed, the 'bag' was said to be quite as big as usual. [Author footnote]
26. Third thing. [Ed.]

27. The state of division in which the essential matter issues varies very much in different cases and in different stages of the same case. In some cases the yellow matter is gradually fretted away from the ulcers, in a finely divided state, in others it is cast off in large sloughs. [Author footnote]
28. Having taught this doctrine here, in Bristol, for many years, it was a great gratification to me to find that Professor Viermer of Zurich, a physician of the highest eminence, had been led to the same view, in its application to the case of cholera, on entirely independent evidence. His ideas on the subject will be found in a pamphlet, published by him at Zurich, in 1867, under the following title: 'Ueber die Ursachen der Volkskrankheiten, insbesondere der Cholera.' [Author footnote]
29. The illustration applies with still greater exactness to the excreta of cholera and tubercle. [Author footnote]
30. Tea. [Ed.]
31. I have ascertained from the writer that this narrative is literally true. [Author footnote]
32. Even as I write, the following newspaper cutting is put into my hands:—'According to the "Inverness Advertiser," an examination of all the milk-carts coming into that town has led to the discovery that only two out of a dozen on the east side of the river carried milk entirely unmixed.' [Author footnote]
33. The sewage connection between these workhouses and the brook was severed some years ago. As this story, from its perfect authenticity, may possibly cause some panic, it may be a satisfaction to know that, as far as the propagation of specific disease goes all risk may be abolished by *boiling* the milk, however deeply it may be polluted. Drinking unboiled milk is like eating raw meat, and its open to the same pathological order. I have no doubt that, if all milk were boiled before being used, a marked diminution in the prevalence of more than one very serious type of disease would soon follow. [Author footnote]
34. The Privy Council account of this epidemic has been already given at p. 24. [Author footnote]
35. I exclude, as by right, the case of two inmates of the second division, who, although sleeping in their own part of the house, were employed all day in the fever-stricken part. [Author footnote]
36. See 'Cholera and Disinfection, or Asiatic Cholera in Bristol in 1866,' by W. Budd, M.D. Also 'Second Report of Royal Sanitary Commission,' vol. iii. pp. 46–7. [Author footnote]
37. I subjoin the paragraph in which this suggestion is reported:—'Schools, public and private, constitute a special case where the adoption of this principle is urgently required, on account of the great prevalence of infectious diseases among the young. Hospitals are another, as being places where infectious diseases are being treated and congregated. I have been able myself to trace many severe outbreaks of self-propagating diseases to emanations from hospital sewers. I am of opinion that many evil things little suspected at present of such an origin have very probably a similar source, and I think that would be a very interesting subject for investigation. It is certain at any rate that many malignant forms of disease, which are but too well known within the hospital itself to have the terrible power of self-propagation, feed the sewers largely with very specific excreta, and I would desire to impress the Commission with my very

strong conviction that the permanent disinfection of the sewers of all hospitals should be enforced by law. I have no doubt that a great improvement of health within the hospital itself will follow. All those recommendations have double force in hot climates, in the conditions attaching to campaigns, to emigrant ships, and so on. I am of the opinion that if they were universally acted upon, their beneficial influence would soon be made apparent in a sensible reduction of mortality.' [Author footnote]

38. Conscientiously. [Ed.]
39. Although the fact does not in any way qualify the conclusions suggested by the text, I think it right to state that after the fever had quite died out, the main drain of the reformatory was examined and found to be considerably out of order. On leaving the building this drain—a large earthenware pipe—traversed the court already described, receiving the surface drainage of the court through a well-trapped sink in the centre. It had been the practice to store large quantities of coal in this court out in the open, and wherever heavy rain came on small coal was freely washed into the drain. The sludge of the sewage had formed a concrete, which was literally almost-as-hard as stone, and which completely blocked the pipe. On pursuing the examination further another defect was found, which in great degree neutralised the effect of the first. Exactly within the boundary wall of the building the drain-pipe had come to pieces in such way that the whole of the sewage of that part of the building discharged into a large excavation in the ground made when the foundations were dug. As there had never been any actual regurgitation either through the sink or further back, the breaking of the pipe must necessarily have occurred either before its occlusion further on or must have coincided with it. The stoppage itself was probably a very gradual thing partial; probably, at first, possibly intermittent also, in obedience to the varying degree of pressure from behind, through rainfall or otherwise. Such a state of things would explain perfectly the recurrent difficulties which occurred in the drainage on that side of the house. In the same way the fracture of the pipe would explain the cessation from these difficulties already spoken of in the text. It is of course, in a case like this, impossible to give an exact estimate as to time, but the builder who conducted the investigation, and who was a man of great experience, felt confident, judging from the hardness of the concrete on the one hand, and the amount of sewage accumulated under the basement of the house on the other, that the state of things he found must have existed for a twelvemonth at least. Its general effect may be stated with scientific precision by saying that it had converted the drainage of the reformatory from drainage by sewer, into drainage by cesspool. But concede the principle of cesspool and nothing could be better than this. The traps were all in good order, and the cavity into which the sewage discharged was large, and was enclosed on all sides by solid masonry. That the conditions here described might have helped in giving effect to the contagion is possible, although by no means sure. That they were the actual cause of the outbreak is a supposition too preposterous to be worth considering. [Author footnote]
40. In one, only, case (referred to in the appendix), a servant girl, who nursed a lady in a severe attack of typhoid, herself took the fever. But in that case the disinfection was not complete. [Author footnote]

41. “The cause of contagious diseases is then no longer found in putrid vapors or atmospheric variations no matter how extreme or terrible.” [Hill]
42. “Inclined to things wrong, they reject the better things.” [Hill]
43. The considerations advanced in this and one or two subsequent pages have already, in part, been brought before the reader in preceding chapters. But the facts in which they are founded are so important in their bearing on the origin and mode of spreading of typhoid fever, that I make no apology for reproducing them in somewhat fuller development. [Author footnote]
44. The very large proportion in which, wherever the reckoning has hitherto been made, persons new from the country figure among the fever-patients of large cities, may be explained by reference to the same considerations. Louis has pointed out with his wonted clearness, that this peculiarity is mainly, if not wholly due to the circumstance *that in the city the disease is always present, but in the country only now and then.* (Recherches sur la Fièvre Typhoïde, 1re edit. tome ii. p. 735.) [Author footnote]
45. See appendix. [Author footnote]
46. Several instances of this came to my knowledge. [Author footnote]
47. Not that there is any reason to suppose that the typhoid poison is offensive to the nose or even cognisable by it. But as according to the pythogenic theory this poison is the offspring of putrescence, while stink is the surest of all indices of it, the magnitude of the stink may be taken as a measure of the magnitude of the scale on which pythogenic products are being generated. [Author footnote]
48. Upon changing that to be changed. [Ed.]
49. The greater and more rapid diffusiveness of the contagious exanthemata constitutes a difference, not of essence, but of form merely. The law by which the poison is reproduced is the same in both cases. The exanthemata spread more widely and more rapidly, partly because (there is reason to believe) the poisons by which they are propagated are more prolific than the typhoid, and partly because, from being cast off mainly by the outward surface of the body, they are sown broadcast from the first, and not held, as the typhoid poison is, in a certain degree to the ground. [Author footnote]
50. ‘On the Influence of Contagion in the Diffusion of Epidemic Disorders.’ [Author footnote]
51. Dr. Murchison fed a pig for three months with the discharges from intestinal fever, and found that the health of the animal in no wise suffered from this strange addition to its diet the inference which the fact might, at first sight, seem to suggest—that these discharges are not infectious—is, I need scarcely say, quite unwarranted by it. The true inference to draw from it is, that the typhoid fever of man is not thus communicable to the pig. Although this animal is subject to an intestinal fever of its own, there is reason to believe that it is quite insusceptible of human typhoid. [Author footnote]
52. If anything were wanting to add force to this, it would be the fact that animals, on their part are infested by a whole brood of contagious poisons, specific in kind, each separate from the other, and all (with one or two exceptions) incapable, apparently, of multiplying in the *human* body. It seems to be quite established, for instance, that cattle are subject to a variety of malignant and contagious fevers—many of them of typhoid-type from which man is altogether exempt. [Author footnote]

53. The whole practice of vaccination is based upon an immunity—less in degree, but the same in kind—acquired by the inoculation of vaccine. [Author footnote]
54. Some ingenious suggestions on the subject may be found in Liebig's 'Agricultural Chemistry,' under the head of Fermentation; and Mr. Paget has made some very interesting reflections upon it in his 'Lectures on Surgical Pathology,' as illustrating the incomparable precision of the assimilative act. Sir H. Holland has also treated the matter generally in an admirable and most suggestive essay, 'On Diseases which occur only once in Life.' But although these eminent men have no doubt hit upon important elements of the problem, their speculations must not be mistaken for actual solution of it. [Author footnote]
55. When MM. Louis and Trousseau were sent by the French Government to report upon the great epidemic of yellow fever at Gibraltar, they observed a great number of cases of striking exemption in persons who were infants at the breast when the disease prevailed epidemically there before; and who, to use the expression of the Gibraltar people, had sucked the fever with their mother's milk. (See Trousseau's *Clinique Médicale*-Lecture on Contagion.) [Author footnote]
56. Tausend Keime zerstreuet der Herbst, doch bringet kaum einer Fruchte; zum Element kehren die meisten zuruck. Aber entfaltet sich auch nur einer, einer allein streut Eine lebendige Welt ewiger Bildungen aus.—Schiller. [Author footnote] This quote is from Schiller's poem entitled "Verschiedene Bestimmungen" or "Different Destinies." The selected lines translate as "Fall spreads thousands of seeds, but rarely do they become a fruit; most of them return to the elements. But if just one evolves (develops), it gives rise to (spreads) an agile (lively) world of everlasting education." [Translated by Ralph Buehler, Ph.D.]
57. It appears that cowpox at times may infect unexpectedly some individuals who have not had contact with those already infected. Nevertheless, [he has determined that] for eleven hundred years cowpox was unknown in Europe and remained unknown in some islands in the Pacific Ocean until the Europeans arrived there. [Hill]
58. See for this and other similar instances, an admirable Report on Contagion by Dr. Henry, of Manchester, in one of the early volumes of the 'Transactions of the Provincial Medical and Surgical Association.' [Author footnote]
59. In times of epidemic, and among the lower classes, the spread of the disease in many cases can, of course, be followed. [Author footnote]
60. 'That it did not sooner extend westward into Persia,' Sir T. Watson continues, 'and thence into Greece, may be attributed partly to the horror which the disease everywhere inspired, and the attempts that were consequently made to check its progress, by prohibiting all communication with the sick; partly, to the limited intercourse which then took place among the eastern nations, but, principally, to the peculiar situation of the regions through which the infection was diffused; separated, as they were, from the rest of the world by immense deserts, and by the ocean;'—Watson's *Lecturer on the Practice of Physic,* 3rd edit. vol. ii. p. 709. [Author footnote]
61. This passage was written in 1872, at the date of the last importation of the Cattle Plague into England, the Plague being speedily extinguished by the measures indicated in the text. [Author footnote]

62. The exact words are: 'La spontanéité est donc un fait incontestable dans le développement des maladies meme les plus contagieuses. Et en effet la contagion impliquant nécessairement la présence de deux individus, l'un donnant l'autre recevant le germe morbifique, c'est une vérité par trop banale de dire que chez le premier qui fut atteint d'une maladie contagieuse, la maladie se developpa spontanément; qu'elle se forma de toutes pièces sous l'influence de causes qui nous sont complètement inconnues.' Clinique médicale, tome 1er, article *Contagion* [Author footnote]. Translated as "Spontaneity is then an incontestable reality in the development of the most contagious diseases. And as a result, contagion implying necessarily the presence of two individuals, one giving, the other receiving the disease-causing germ, which is to say something excessively commonplace, namely, that at the time of the first person who was suffering from a contagious disease, the disease developed spontaneously, as if it was formed at all points under the influence of causes which were completely unknown to us.' Medical clinic, volume 1, article Contagion." [Hill]
63. As a piece of natural history, the whole subject of parasites is a very curious one; and its study, if carried out, would probably lead to some very unexpected inferences. The topic is one which should commend itself, one would fancy, in a peculiar way to the fertile and ingenious mind of Mr. Darwin. [Author footnote]
64. This peculiarity is strictly parallel to the primary appearance of particular species of plants and animal; in certain geographical centres, often of very limited area. Mr. Darwin's attempt to explain the fact is well known. I am not competent to say how far it is successful, or whether and to what extent the same principle is applicable to specific diseases. I may at some future time have something to say on this last point. Meanwhile, the fact itself, as connected with the origin and spread of contagious disorders, would form a very interesting subject for an essay in the hands of anyone competent to deal with it. [Author footnote]
65. "Life is serious (earnest/stern/austere)." [Buehler]
66. As the discharge is sometimes much more copious than at others, the quantity of disinfectant added must of course be copious in the same proportion. A teacupful is mentioned in the rules, but the principle is to be lavish of the chemical. [Author footnote]
67. A resin from the Isonandra Gutta tree is used as an insulating material; the first natural plastic. [Cable and Wireless History, www.cwhistory.com/history/html/GuttaPer.html]
68. Anyone who may desire to reprint these Rules for general use, has the full permission of the writer to do so. [Author footnote]
69. The facts relating to the Cowbridge outbreak, related in a former chapter, show, however, that under certain conditions it may be much shortened. [Author footnote]
70. In the one exceptional case, a servant girl, who nursed a lady through her whole illness, caught the fever. In the lady the chief stress of the disease, as sometimes happens, fell on the lungs, and, for some time, there was much cough and expectoration. Now, although the discharges from the bowel were disinfected, nothing was done to the sputa, or the numerous pocket handkerchiefs that were soiled with them. As there are strong pathological grounds

for believing that, under such circumstances, the pulmonary excreta may convey the fever, the disinfection, in this case, cannot be regarded, therefore, as being complete. [Author footnote]

Chapter 15 NIGHTINGALE

1. In Paris, an Annual Report of the Hospitals ('Compte Moral Administratif') is published. But the only useful statistical information to be gleaned from it is the number of *sous* each patient has cost. For, although it gives the numbers of adults, male and female, and of children who have been admitted, and who have died during the year, yet this in itself tells little.

   If the Hospitals of London and of Paris would give us the information contained under the eight following heads, so important would be the knowledge thereby conveyed, that it would be worth while to go back for many years to construct such tables, and to continue the same forms hereafter.

   1. The numbers admitted for each decennial period of age for each sex per annum.
   2. The number, similarly arranged, remaining in hospital at the end of the preceding year.
   3. The numbers dead for each sex at each decennial period of age per annum.
   4. The numbers discharged cured similarly arranged per annum.
   5. The numbers discharged incurable similarly arranged per annum.
   6. The numbers remaining in hospital at the end of the current year similarly arranged.
   7. The diseases remaining, admitted, died, cured, discharged incurable, and remained, arranged for each sex and each decennial period of age per annum.
   8. The duration of cases, similarly arranged. [Author footnote]

2. To show the great importance of this point I give the following tables, kindly prepared by Dr. Farr, from returns furnished to me with the greatest readiness by fifteen of the metropolitan hospitals. Table I gives the ages of living and dying among the nursing staff. Table II gives the mortality from zymotic diseases, and the comparison between the nurses' mortality and the mortality of the female population of London. [Tables not included. Ed.]

   The fatal zymotic diseases included in this table are fever and cholera, and it will be seen that these two diseases occasioned nearly 50 per cent. of the total mortality among the nursing staff as against 16 per cent. among the London population. This single fact is quite enough to prove the very great importance of hospital hygiene. The calculated total mortality is also very much higher among the nurses, even if we assume that the deaths in the returns are all the deaths due to hospital nursing, which is very doubtful. If we assume that the non-zymotic mortality among nurses ought to be the same as it is among the female population, and if to this we add the zymotic deaths among nurses, we find the total mortality among nurses to exceed the total mortality among the female population of the metropolis by about 40 per cent. The loss of a well-trained nurse by preventible disease is a greater loss than is that of a good soldier from the same cause. Money cannot replace either, but a good nurse is more difficult to find than a good soldier.

The data from which these tables have been deduced are imperfect, and it would be very desirable if in future all hospitals would keep a register of nurses. The following form would be one well calculated to give the required information. The subject is of additional importance in connexion with the proper working of a Superannuation Fund for nurses:—[Table not included. Ed.] [Author footnote]

3. The history of the doctrine of 'Contagion' is given by Dr. Adams in his very learned translation of the works of Paulus Aegineta, Vol. I, p. 284—(Sydenham Society). He says, in his comment, 'the earlier ancient authors appear to have entertained no suspicions of contagion as a cause of febrile or of other complaints.

   'The works of the fathers of history, and of medicine, have likewise been ransacked in vain for any traces of the doctrine of contagion.'

   Thucydides, and after him several of the Latin poets describe the plague of Athens, which appears to have been a form of Dysentery, as communicable from person to person. The later Greek historians contain allusions to the infectious nature of certain diseases; but Procopius, though cognizant of one of the greatest pestilences on record, was a non-contagionist.

   Virgil's allusions to contagious diseases among cattle will be found in Ecl. I. Georg. III., 464.

   Aretaeus appears to be the first medical author who believed in contagion. Galen seems to have held the doctrine of infection. Of the later Greek and Arabian medical writers, some were contagionists, and others make no allusion to the subject. Dr. Adams states, in regard to plague, a disease which, in later times, has been considered as the very type of all 'contagious' pestilences, 'The result of our investigations into the opinions of the ancients on this subject leads us to the conclusion that all, or at least the most intelligent of the medical authorities, held that the plague was communicated not by any specific virus, but in consequence of the atmosphere around the sick being contaminated with putrid effluvia.'

   The obvious practical result of this view of infection is, that abundance of pure air will prevent infection. All my own hospital experience confirms this conclusion. If infection exists, it is preventible. If it exists, it is the result of carelessness, or of ignorance. 'Contagion,' as a doctrine, on which distinct practical proceedings have been taken, appears to be of very modern invention; but it has been not the less injurious to civilization and humanity, from the loss of life which has from time to time followed from the practices which it inculcates, and from the immense tax which it has entailed upon commerce. [Author footnote]
4. Curiously enough, these directly communicable diseases were excluded from the operation of general quarantine law by the International Quarantine Conference of Paris, 1851, which restricted the objects of quarantine to plague, yellow fever, and cholera, while it gave a logical coup de grace to the 'contagion' hypothesis by abolishing the 'suspected bill of health.' [Author footnote]
5. It must never be forgotten that, during the last six months of our occupation in the Crimea, the death rate among our men, barracked in huts, was only two-thirds of what it is among the men in barracks at home. [Author footnote]
6. 'Catching cold' in bed follows the same law as 'catching cold' when up. If the atmosphere is foul, and the lungs and skin cannot therefore relieve the system,

then a draught upon the patient may give him cold. But this is the fault of the foul air, not of the fresh. [Author footnote]

7. On the Dardanelles during the Crimean War. [Author footnote]
8. Polisher. [Ed.]
9. Polishing. [Ed]
10. Straw mattress. [Ed.]
11. The necessary changes having been made. [Ed.]

Chapter 17 KOCH

The Aetiology of Tuberculosis

1. Bovine tuberculosis. [Ed.]
2. Public health authorities. [Ed.]
3. Tubercular. [Ed.]
4. A highly contagious and very destructive disease of horses, asses, mules, etc., characterized by a constant discharge of sticky matter from the nose, and an enlargement and induration of the glands beneath and within the lower jaw. It may transmitted to dogs, goats, sheep, and to human beings. [*Webster's Unabridged Dictionary*, 1913]

On Bacteriological Research

1. "Ueber bakteriologische Forschung," delivered at *Verhandlungen des X. Internationalalen Medizinischen Kongresses*, Berlin, August Hirschwald, 1890. [Author footnote]
2. Angiolo Maffucci, "Beiträzur Aetiologie der Tuberculose (Hühner-tuberculose)," Zentralblatt für allgemeine Pathologie und pathologische Anatomie, 1890, 1:409–16. [Author footnote]
3. A viral disease of cloven-hoofed animals caused by *Morbillivirus*. It may be acute, subacute, or chronic with the major lesions characterized by inflammation and ulceration of the entire digestive tract. [*Webster's Online Dictionary*, 2004]
4. An acute, subacute or chronic respiratory disease of cattle caused by *Mycoplasma mycoides mycoides* SC (small colony). [*Foreign Animal Diseases, The "Gray Book,"* 6th ed., United States Animal Health Association at www.vet.uga.edu/vpp/gray_book/]
5. An acute infectious disease of cattle, sheep or pigs (blackleg, blackquarter, black-quarter, *Clostridium chauvoei* infection, *Clostridium septicum* infection, quarter-ill, or symptomatic anthrax). [*Webster's*]
6. Theodor Billroth, "Ueber die Behandlung kalter Abscesse und tuberculöser cariesmit Jodoformemulsion," Wienerklinische Wochenschrift, 1890; 3:201–4, 228–31. [Author footnote]

PART III

Chapter 18 RIIS

1. The term child means in the mortality tables a person under five years of age. Children five years old and over figure in the tables as adults. [Author footnote]
2. See City Mission Report, February, 1890, page 77. [Author footnote]

Chapter 19 SINCLAIR

1. "Rules and Regulations for the Inspection of Live Stock and their Products." United States Department of Agriculture, Bureau of Animal Industries, Order No., 125:—

   SECTION 1. Proprietors of slaughterhouses, canning, salting, packing, or rendering establishments engaged in the slaughtering of cattle, sheep, or swine, or the packing of any of their products, *the carcasses or products of which are to become subjects of interstate or foreign commerce*, shall make application to the Secretary of Agriculture for inspection of said animals and their products. . . .
   SECTION 15. Such rejected or condemned animals shall at once be removed by the owners from the pens containing animals which have been inspected and found to be free from disease and fit for human food, and *shall be disposed of in accordance with the laws, ordinances, and regulations of the state and municipality in which said rejected or condemned animals are located*. . . .
   SECTION 25. A microscopic examination for trichinæ shall be made of all swine products exported to countries requiring such examination. *No microscopic examination will be made of hogs slaughtered for interstate trade, abut this examination shall be confined to those intended for the export trade.* [Author footnote]

Chapter 20 FLEXNER

1. The American Medical Association Bulletin, vol. iii., no. 5, p. 262. [Author footnote]
2. It is interesting to observe the tendency towards conferring only a bachelor's degree in engineering at graduation instead of the degree of C.E., etc. The bachelor in engineering usually goes to work at laborer's wages; he is years reaching the degree of responsibility with which the graduate of medicine usually begins. [Author footnote]
3. Quoted by F. T. Lewis in "The Preparation for the Study of Medicine," Popular Sciences Monthly, vol. 1xxv., no. 2., p. 66. [Author footnote]
4. Including botany. [Author footnote]
5. We shall omit the half-school because it may be considered to divide with the whole school the work of the first two years; it does not greatly affect the clinical output, with which this chapter is mainly concerned. [Author footnote]
6. Chicago is almost an exception, as Northwestern University is situated at Evanston, a suburb. [Author footnote]
7. Not including osteopathic schools. [Author footnote]
8. This chapter now recapitulates and summarizes the more detailed accounts contained in Part II, in which the schools of each state are described and the general state situation discussed. [Author footnote]
9. *The Nature of Man* (translated by Chalmers), p. 300. [Author footnote]

Chapter 23 HAMILTON

1. Teleky: Handwörterbuch der Sozialen Hygiene. Leipzig, 1912, Vol. II, p. 737. [Author footnote]
2. Layet: Hygiène des Professions et des Industries. Paris, 1875. [Author footnote]
3. U.S. Bureau of Labor, Bul. No. 95; Industrial lead poisoning, with descriptions of lead processes in certain industries in Great Britain and the western States of Europe, by Sir Thomas Oliver, M.D., p. 98. [Author footnote]
4. Hirsch, in Deutsche Medizinische Wochenschrift, vol. 40, 1914, p. 369. [Author footnote]
5. Legge and Goadby: Lead poisoning and lead absorption. London, 1912, p. 35. [Author footnote]
6. Oliver: Dangerous Trades. London, 1902, p. 296. [Author footnote]
7. Legge and Goadby: Lead poisoning and lead absorption. London, 1902, p. 35. [Author footnote]
8. Agnes Bluhm in Weyl's Handbuch der Hygiene, vol. 8, 1897, p. 88. [Author footnote]
9. U.S. Bureau of Labor Statistics, Bul. No. 104: Lead poisoning in potteries, tile works, and porcelain enameled sanitary ware factories, by Alice Hamilton, M.D., pp. 56–58. [Author footnote]
10. Prendergast, in British Medical Journal, vol. 1, 1910, p. 1164. [Author footnote]
11. Legge, in Journal of Hygiene, vol. 1, 1901, p. 96. [Author footnote]
12. Oliver, in British Medical Journal, vol. 1, 1911, p. 1906. [Author footnote]
13. Woman's Industrial News. London, July, 1918, No. 81, p. 11. [Author footnote]
14. Tardieu: Poisons Industrielles. Paris, 1905. [Author footnote]
15. Chyzer. Chirurgische Presse. Budapest, vol. 44, 1908, p. 906. [Author footnote]
16. U.S. Bureau of Labor, Bul. No. 95: White-lead industry in the United States, by Alice Hamilton, M.D., p. 259. [Author footnote]
17. U.S. Bureau of Labor Statistics, Bul. No. 141: Lead poisoning in the smelting and refining of lead, by Alice Hamilton, M.D., pp. 82–84. [Author footnote]
18. Idem, pp. 50–53. [Author footnote]
19. Saito, in *Archiv für Hygiene*, 1912, p. 134. [Author footnote]
20. Gautheir, in Breton's *Maladies Professionelles*. Paris, 1911, p. 154. [Author footnote]
21. New York State Factory Investigating Commission Preliminary Report, Albany, 1912, Vol. I, pp. 428–430. [Author footnote]
22. U.S. Bureau of Labor Statistics, Bul. No. 141: Lead poisoning in the smelting and refining of lead, by Alice Hamilton, M.D., pp. 82–84. [Author footnote]
23. Bureau of Labor Statistics, Bul. No. 209: Hygiene of the printing trades, by Alice Hamilton, M.D., and Charles H. Verrill, pp. 21–26. [Author footnote]
24. Idem. [Author footnote]
25. See section on battery manufacture, pp. 32–35. [Author footnote]
26. U.S. Bureau of Labor Statistics, Bul. No. 209: Hygiene of the printing trade, by Alice Hamilton, M.D., and Charles H. Verrill, p. 37. [Author footnote]
27. As stated at the beginning, lead is the only poisonous substance considered here. Cheap paint is usually leadless, but may contain harmful volatile liquids, such as benzene, and naphtha, which set up a train of symptoms when these paints are used in poorly ventilated rooms. [Author footnote]

28. U.S. Bureau of Labor, Bul. No. 95: White-lead industry in the United States, by Alice Hamilton, M.D., p. 259. [Author footnote]
29. U.S. Bureau of Labor Statistics, Bul. No. 165: Lead poisoning in the manufacture of storage batteries, by Alice Hamilton, M.D., p. 23. [Author footnote]
30. U.S. Bureau of Labor Statistics, Bul. No. 165: Lead poisoning in the manufacture of storage batteries, by Alice Hamilton, M.D., p. 24. [Author footnote]
31. This included the men who filled so-called "ironclads" with dry oxides, at that time very dusty, dangerous work, but much less so at present. [Author footnote]
32. U.S. Bureau of Labor Statistics, Bul. No. 104: Lead poisoning in potteries, tile works, and porcelain enameled sanitary ware factories, by Alice Hamilton, M.D., p. 6. [Author footnote]
33. Ohio State Board of Health. A survey of industrial health hazards and occupational diseases in Ohio, by E. R. Hayhurst. Columbus, 1915, pp. 229–256. [Author footnote]

Chapter 24 WOLMAN

1. Dakin and Dunham, Handbook of Antiseptics, 1918, p. 106. [Author footnote]
2. "Some Aspects of Chlorination," J. Am. Water Works Assoc. June, 1916. [Author footnote]
3. "Water Chlorination Experiences at Toronto, Canada," Am. J. Pub. Health, August, 1916. [Author footnote]
4. "Some Aspects of Chlorination," J. Am. Water Works Assoc. June, 1916; "Chlorination and Chloramine," ibid., March, 1918. [Author footnote]
5. "New Perfections in the Chlorination of Waters," La Technique Sanitaire et Municipale, February, 1917. [Author footnote]
6. "Note on the Purification of Potable Water by Calcium Hypochlorite," Office International d'Hygiene Publique, May 1918. [Author footnote]
7. "The Determination of the Useful Dose of Chlorine for the Purification of Water: The Chlorine Index," Compt. Rend., February, 1918. [Author footnote]
8. Rideal, J. Roy. San. Instit., 31 (1910), 33–45, gives 2.2, while Schneider, Bacteriological Method-Food and Drugs, p. 200, gives 12.5. [Author footnote]
9. The determinations were all made according to the 1917 APHA Standard Method of Water Analysis. The oxygen-consumed readings were obtained in acid digestion, with a period of digestion of 30 minutes at a boiling temperature. No corrections for oxidizable mineral substances were applied to the oxygen-consumed values, since these latter were to be used to represent the total oxygen demand of the water supply. In the measurement of available chlorine in the different experiments the temperature used was 20°C. [Author footnote]

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Titles of books are in italics. With page numbers, n refers to note; t refers to table.

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