Margaret M. Stark *Editor*

Clinical Forensic Medicine

A Physician's Guide

Third Edition

Humana Press

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Without the help and patience
of one's family it is impossible to edit
textbooks! So very many thanks
to Mick and Amelia, and canine (Monty)
and feline (Rusty and Olivette) friends for
putting up with "hours of neglect" whilst
this manuscript was being prepared!

Preface to the Third Edition

Clinical Forensic Medicine has still not received the full recognition of speciality status but there have been exciting developments since the publication of the second edition of this textbook. The Faculty of Forensic and Legal Medicine has been established by the Royal College of Physicians of London with the laudable aim of promoting for the public benefit the practice of Forensic and Legal Medicine. The European Council of Legal Medicine has been working to create a speciality of Legal Medicine and the Australasian Association of Forensic Physicians has been established with the aim of seeking formal recognition of Clinical Forensic Medicine as a medical speciality.

Increasingly, other health care professionals (HCP) are involved in many aspects of clinical care previously provided by doctors. Nurses and paramedics are providing general forensic services (custody care) and nurses are performing sexual offence examinations. It is essential that the person providing care to this incredibly vulnerable group of patients (detainees or complainants) has the appropriate knowledge and skills. More than ever, a death in custody or a death following police contact, is intensely scrutinised.

I hope that the third edition will assist all health care professionals in their role in custody and with complainants. All the chapters in this edition have been reviewed and revised. In particular, the chapter on non-accidental injury has had a major rewrite reflecting the recent developments in child protection/safeguarding. There is now a specific chapter on the TASER with other aspects of restraint dealt with separately. Similarly, the Care of Detainees and Fitness for Interview chapters have been separated to allow a more comprehensive discussion of the issues. Some new authors have joined the team of contributors providing a more international perspective. Thanks are due to all contributors for their diligent work.

It is essential that each HCP working in a multidisciplinary team is fully aware of their individual roles and responsibilities and works within his/her field of competence as only then will multidisciplinary team working be effective. I hope that this edition will assist forensic physicians, nurses, and paramedics in providing independent, authoritative, and competent care to detainees and complainants.

Margaret M. Stark

Foreword to the Second Edition

The Metropolitan Police Service (MPS), now in its 175th year, has a long tradition of working with doctors. In fact, the origin of the forensic physician (police surgeon) as we know him or her today, dates from the passing by Parliament of The Metropolitan Act, which received Royal Assent in June of 1829. Since then, there are records of doctors being "appointed" to the police to provide medical care to detainees and examine police officers while on duty.

The MPS has been involved in the training of doctors for more than 20 years, and has been at the forefront of setting the highest standards of working practices in the area of clinical forensic medicine. Only through an awareness of the complex issues regarding the medical care of detainees in custody and the management of complainants of assault can justice be achieved. The MPS, therefore, has worked in partnership with the medical profession to ensure that this can be achieved.

The field of clinical forensic medicine has developed in recent years into a specialty in its own right. The importance of properly trained doctors working with the police in this area cannot be overemphasized. It is essential for the protection of detainees in police custody and for the benefit of the criminal justice system as a whole. A book that assists doctors in the field is to be applauded.

Sir John Stevens

Preface to the Second Edition

The field of clinical forensic medicine has continued to flourish and progress, so it is now timely to publish *Clinical Forensic Medicine: A Physician's Guide, Second Edition*, in which chapters on the medical aspects of restraint and infectious diseases have been added.

Police officers are often extremely concerned about potential exposure to infections, and this area is now comprehensively covered. The results of the use of restraint by police is discussed in more detail, including areas such as injuries that may occur with handcuffs and truncheons (Chapters 7, 8, and 11), as well as the use of crowd-control agents (Chapter 6). The chapter on general injuries (Chapter 4) has been expanded to include the management of bites, head injuries, and self-inflicted wounds.

Substance misuse continues to be a significant and increasing part of the workload of a forensic physician, and the assessment of substance misuse problems in custody, with particular emphasis on mental health problems ("dual diagnosis"), has been expanded. Substance misuse is too often a cause of death in custody (Chapter 10).

Traffic medicine is another area where concerns are increasing over the apparent alcohol/drugs and driving problem. There has been relevant research conducted in this area, which is outlined Chapter 12.

Forensic sampling has undergone enormous technological change, which is reflected in the chapter on sexual assault examination (Chapter 3).

The chapter on the history and development of clinical forensic medicine worldwide has been updated (Chapter 1). Chapters on fundamental principles (Chapter 2), nonaccidental injury in children (Chapter 5), and care of detainees (Chapter 8) are all fully revised, as are the appendices (now containing a list of useful websites). Although the subject is constantly evolving, some fundamental principles remain.

I was very pleased with the response to the first book, and there appears to be a genuine need for this second edition. I hope the good practice outlined in this book will assist forensic physicians in this "Cinderella speciality."

Margaret M. Stark

Preface to the First Edition

"Clinical forensic medicine"—a term now commonly used to refer to that branch of medicine involving an interaction among the law, the judiciary, and the police, and usually concerning living persons—is emerging as a specialty in its own right. There have been enormous developments in the subject in the last decade, with an increasing amount of published research that needs to be brought together in a handbook, such as *A Physician's Guide to Clinical Forensic Medicine.* The role of the health care professional in this field must be independent, professional, courteous, and nonjudgemental, as well as well-trained and informed. This is essential for the care of victims and suspects, for the criminal justice system, and for society as a whole.

As we enter the 21st century it is important that health care professionals are "forensically aware." Inadequate or incorrect diagnosis of a wound, for example, may have an effect on the clinical management of an individual, as well as a significant influence on any subsequent criminal investigation and court proceedings. A death in police custody resulting from failure to identify a vulnerable individual is an avoidable tragedy. Although training in clinical forensic medicine at the undergraduate level is variable, once qualified, every doctor will have contact with legal matters to a varying degree.

A Physician's Guide to Clinical Forensic Medicine concentrates on the clinical aspects of forensic medicine, as opposed to the pathological, by endeavoring to look at issues from fundamental principles, including recent research developments where appropriate. This volume is written primarily for physicians and nurses working in the field of clinical forensic medicine—forensic medical examiners, police surgeons, accident and emergency room physicians, pediatricians, gynecologists, and forensic and psychiatric nurses—but such other health care professionals as social workers and the police will also find the contents of use.

The history and development of clinical forensic medicine worldwide is outlined, with special focus being accorded the variable standards of care for detainees and victims. Because there are currently no international standards of training or practice, we have discussed fundamental principles of consent, confidentiality, notekeeping, and attendance at court.

The primary clinical forensic assessment of complainants and those suspected of sexual assault should only be conducted by those doctors and nurses who have acquired specialist knowledge, skills, and attitudes during both theoretical and practical training. All doctors should be able to accurately describe and record injuries, although the correct interpretation requires considerable skill and expertise, especially in the field of nonaccidental injury in children, where a multidisciplinary approach is required.

Avoidance of a death in police custody is a priority, as is the assessment of fitness-to-be-detained, which must include information on a detainee's general medical problems, as well as the identification of high-risk individuals, i.e., mental health and substance misuse problems. Deaths in custody include rapid unexplained death occurring during restraint and/or during excited delirium. The recent introduction of chemical crowd-control agents means that health professionals also need to be aware of the effects of the common agents, as well as the appropriate treatments.

Custodial interrogation is an essential part of criminal investigations. However, in recent years there have been a number of well-publicized miscarriages of justice in which the conviction depended on admissions made during interviews that were subsequently shown to be untrue. Recently, a working medical definition of fitness-to-be-interviewed has been developed, and it is now essential that detainees be assessed to determine whether they are at risk to provide unreliable information.

The increase in substance abuse means that detainees in police custody are often now seen exhibiting the complications of drug intoxication and withdrawal, medical conditions that need to be managed appropriately in the custodial environment. Furthermore, in the chapter on traffic medicine, not only are medical aspects of fitness-to-drive covered, but also provided is detailed information on the effects of alcohol and drugs on driving, as well as an assessment of impairment to drive.

In the appendices of A *Physician's Guide to Clinical Forensic Medicine,* the relevant ethical documents relating to police, nurses, and doctors are brought together, along with alcohol assessment questionnaires, the mini-mental state examination, and the role of appropriate adults; the management of head-injured detainees, including advice for the police; the Glasgow Coma Scale, and an example of a head injury warning card; guidance notes on US and UK statutory provisions governing access to health records; an alcohol/drugs impairment assessment form, along with a table outlining the peak effect, half-life, duration of action, and times for detection of common drugs.

Margaret M. Stark

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Chapter 1
Clinical Forensic Medicine: History and Development

Jason J. Payne-James and Margaret M. Stark

Introduction

The term "forensic medicine" is now used to embrace all aspects of forensic work of a medical nature. In the past, the term was often used interchangeably with "forensic pathology" – the branch of medicine which investigates death. Nowadays the phrase "clinical forensic medicine" is properly applied to that part of medical practice whose scope involves interaction between the law, the judiciary, and the police involving (generally) living persons. Clinical forensic medicine is a term that has become widely used only in the last three decades or so, although the phrase has been used at least since 1951 in the UK, when the National Association of Police Surgeons (which became the Association of Forensic Physicians in 2003 till its demise in 2006) was first established. The absence of a clear medical specialty of clinical forensic medicine has resulted in practitioners of clinical forensic medicine being given many different descriptive names over the years. The term "forensic physician" (FP) is now widely accepted. Police surgeon, divisional surgeon, forensic medical officer (FMO) and forensic medical examiner (FME) are examples of other names or titles that have been used to describe those who practice in the specialty of clinical forensic medicine, but names such as these refer more to the appointed role than to the work done. Worldwide, there are many who are involved in both clinical and pathological aspects of forensic medicine. Generally, however, a forensic pathologist does not deal with living individuals, and an FP does not deal

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with the deceased. There is substantial overlap in the clinical and pathological aspects of forensic medicine, and this is reflected in the history and development of the specialty as a whole and its current practice and literature today [1, 2].

Table 1.1 shows specific roles that any FP may be asked to undertake in the UK [3]. The table also includes examples of additional roles that senior FPs may undertake. Some practitioners of clinical forensic medicine may only perform some of these roles – for example, focusing on custodial medicine alone, or sexual offence medicine alone, or child maltreatment, whereas others may play a more extended role, depending on geographic location (in terms of country and state), local statute and judicial systems. FPs should have a good knowledge of medical jurisprudence – the application of medical science to the law within their own jurisdiction. The role and scope of the specialty of clinical forensic medicine remain ill-defined in global terms, unlike other well-established medical specialties such as gastroenterology or cardiology. In many cases, doctors practicing clinical forensic medicine or medical jurisprudence may only take on these functions as subspecialties within their own general workload. Paediatricians, emergency medicine specialists, primary care physicians, psychiatrists, gynaecologists and genitourinary medicine specialists often have a part-time role as FPs.

Table 1.1 Roles of an independent forensic physician

Part A

Specific functions

Detainee examinations:

The custodians of detainees are obliged to call an appropriately trained health care professional (HCP) when they suspect, or are aware of, any physical illness, mental health problem, or injury of the detainee. Following an initial assessment by the healthcare professional the FP may be called, or in many areas the request passes directly to the duty FP. The FP in attendance is responsible for the clinical needs of a detainee and should also consider their well-being (food, drink, rest, warmth etc.).

The doctor is usually requested to provide an opinion on one or more of the following

- Fitness to be detained in police custody, e.g. requirement for medication, referral to hospital
- Fitness to be released, e.g. sobered up sufficiently to release safely, consideration of any risk to public safety, or the personal well-being of the detainee where there are suicidal thoughts
- Fitness to be charged: competent to comprehend charge
- Fitness to transfer, e.g. when wanted on warrant elsewhere, possibly necessitating a long journey
- Fitness to be interviewed by the police
- Requirement of an appropriate adult, e.g. vulnerable, mentally disordered
- Assessment of alcohol and drug intoxication and withdrawal
- To assess whether there is a "condition that might be due to a drug" under Road Traffic Act Legislation
- Undertake intimate body searches for drugs (not on police premises)

Prisoner and alleged victim examinations

The doctor is expected to

- Ensure the safeguarding of vulnerable adults and children
- Arrange appropriate treatment/referral including for emergency contraception, post-exposure prophylaxis and STI screening

(continued)

Table 1.1 (continued)

- Make precise documentation and interpretation of injuries
- Take forensic samples as appropriate after discussion with investigating officer
- Deal with police officers injured while on duty, including needle stick injuries and at-risk exposure
- Pronounce life extinct at a scene and give an opinion on whether there are any suspicious circumstances
- Give an opinion at certain scenes in relation to bony remains
- Give advice to the police when requested
- Undertake mental state examinations

In addition, doctors with sufficient training and experience may be requested to

- Examine adult complainants of serious sexual assault and the alleged perpetrators
- Examine alleged child victims of neglect, physical or sexual abuse
- Undertake mental health assessments and become Section 12 (MHA 1983 England and Wales) approved forensic physicians
- Examine those detained under Terrorism legislation and be responsible for leading a multidisciplinary team and setting a management plan

Part B

Senior forensic physicians and those with particular skills may also have other broad roles including

- Giving expert opinion in courts and tribunals
- Death in custody investigation
- Pressure group and independent investigators in ethical and moral issues
    - Victims of torture
    - War crimes
    - Female genital mutilation
- Refugee medicine (medical and forensic issues)
- Asylum seeker medicine (medical and forensic issues)
- Implement principles of immediate management in biological or chemical incidents

For all these examinations, a forensic physician must accurately document findings and when needed produce these as written reports for appropriate civil, criminal, coronial courts or other agencies such as disciplinary tribunals. The forensic physician must be able to present the information orally, clearly and concisely to a court, tribunal or other forum

The roles in Part A are adapted from [3]

Historical References

The origins of clinical forensic medicine go back many centuries, but as Smith stated in 1951 that "forensic medicine [cannot be thought of] as an entity … until a stage of civilization is reached in which we have … a recognizable legal system … and an integrated body of medical knowledge and opinion" [4].

In the English language, the specific terms *forensic medicine* and *medical jurisprudence* (also referred to as juridical medicine) date back to the early nineteenth century. In 1840, Thomas Stuart Traill [5] made reference to the connection between medicine and legislation and stated "it is known in Germany, the country in which it took its rise, by the name of State Medicine, in Italy and France it is termed Legal Medicine; and with us [in the United Kingdom] it is usually denominated Medical Jurisprudence or Forensic Medicine". Forensic medicine developed in a number of jurisdictions in parallel and there is dispute as to when medical expertise in the determination of legal issues was first used. It is generally accepted that one of the earliest examples is that identified by Chinese archaeologists who (in 1975) discovered a number of bamboo pieces dating from about 220 BC (Qin dynasty) with rules and regulations for examining injuries inscribed on them. Other historical examples of the link between medicine and the law can be found around the world.

Amundsen and Ferngren [6] in studies of physicians in legal settings concluded that forensic medicine was used by Athenian courts and other public bodies and that the testimony of physicians in matters of a medical nature was given particular credence although this use of physicians as expert witnesses was "loose and ill-defined" [7]. In the Roman Republic, the "Lex Duodecim Tabularum" (laws drafted on 12 tablets and accepted as a single statute in 449 BC) had minor references to medico-legal matters, including length of gestation (to determine legitimacy), disposal of the dead, punishments dependent on the degree of injury caused by an assailant, and poisoning [8]. Papyri related to Roman Egypt dating from the latter part of the first to the latter part of the fourth century AD contain information about forensic medical examinations or investigations [9].

The evidence for a relationship between medicine and the law in these periods is undoubted, but the specific definition and role of forensic medicine, as interpreted by historical documents, remain open to dispute, with the degree and extent of forensic medical input acknowledged depending on the historian undertaking the assessment.

A specific role for the medical expert as a provider of impartial opinion for the judicial system appears to be identified clearly by the Justinian Laws between 529 and 564 AD. Traill [5] stated that "Medical Jurisprudence as a science cannot date farther back than the 16th century". He identified George, Bishop of Bamberg, who proclaimed a penal code in 1507, as the originator of the first codes in which medical evidence was a necessity in certain cases. The "Constitutio Criminalis Carolina", the code of law published and proclaimed in 1553 in Germany by Emperor Charles V, is considered by many to have formed the origin of Legal Medicine as a specialty: expert medical testimony became a requirement rather than an option in cases of serious crime such as murder, wounding, poisoning, hanging, drowning, infanticide and abortion . Medico-legal autopsies were well documented in parts of Italy and Germany five centuries before the use of such procedures by English coroners. The use of such expertise was not limited to deaths or to mainland Europe. Cassar [10], for example, describes the earliest recorded Maltese medico-legal report (1542): medical evidence established that the male partner was incapable of sexual intercourse and this resulted in a marriage annulment. Beck [11] identifies Fortunatus Fidelis as the earliest writer on medical jurisprudence – with his "De Relationibus Medicorum" which was published in Palermo, Italy in 1602. Subsequently Paulus Zacchias wrote "Quaestiones Medico-Legales" described by Beck as "his great work" between 1621 and 1635. Beck also refers to the Pandects of Valentini published in Germany in 1702 which he describes as "an extensive retrospect of the opinions and decisions of preceding writers on legal medicine". In France in 1796 Fodere published the first edition in three octavo volumes of his work "Les Lois E'clairees par les Sciences Physique, ou Traite de Medicine Legale et d'Hygiene Publique".

Late Eighteenth Century Onwards

From the latter part of the eighteenth century, a number of books and treatises were published in the English language on the topics of forensic medicine and medical jurisprudence. What is remarkable is that the issues addressed by many of the authors would not be out of place in a contemporary setting. Table 1.2 shows the Table of Contents of John Gordon Smith's book ("The Principles of Forensic Medicine: Systematically Arranged") in 1821 [12].

Table 1.2 Chapter contents of John Gordon Smith's 1821 "The principles of forensic medicine; systematically arranged"

Class I: Questions that regard the extinction of human life	
Section 1	Of sudden death in the healthy state
	Chapter 1
	Of the reality of death
	The phenomena of death
	States of the living body resembling death
	Tests of the reality of death
	Recapitulation of the phenomena
	Chapter 2
	Sudden death, without cause of crimination
	Sudden death from intrinsic or morbid causes
	Sudden death from external, but natural causes
Section 2	Death by personal agency or homicide
	Chapter 1
	Of poisoning
	Mineral poisons
	Vegetable poisons
	Animal poisons
	Occult poisoning
	Chapter 2
	Suffocation
	Noxious inhalation
	Drowning
	Hanging
	Strangling
	Smothering

(continued)

Table 1.2 (continued)

	Chapter 3
	Wounds and bruises
	Wounds etc of the head
	Wounds of the neck
	Wounds of the thorax
	Wounds of the abdomen
Section 3	Death by spontaneous agency, or suicide
Section 4	Infanticide
	Chapter 1
	Criminal abortion
	Chapter 2
	Infanticide, strictly so called
	Survivorship
Class 2: Questions arising from injuries done to the person, not leading to the extinction of life	
Section 1	Mutilation
Section 2	Rape
Class 3: Disqualification for the discharge of social or civil functions	
Section 1	Mental disqualification
	Chapter
	Mental alienation
	Mania
	Melancholia
	Fatuitas
Section 2	Disqualifications strictly physical
	Chapter 1
	Disqualifications for general purposes
	Chapter 2
	Disqualifications for military service
	Chapter 3
	Disqualifications for the matrimonial state
	Impotence
	Sterility
	Diseases
Section 3	Pretended disqualifications
Section 4	Miscellaneous questions
	Chapter 1
	Utero-gestation
	The phenomena of pregnancy
	The termination and consequences of utero-gestation
	Of the duration of pregnancy
	Supplementary observations
	Chapter 2
	Sexual ambiguity
	Chapter 3
	Personal identity

In 1783 William Hunter [13] published an essay "On the Uncertainty of the Signs of Murder in the Case of Bastard Children"; this may be the first true "forensic medicine" publication from England. The first larger work was published in 1788 by Samuel Farr. John Gordon Smith writes in 1821 in the Preface to his own book [12] "The earliest production in this country, professing to treat of Medical Jurisprudence *generaliter,* was an abstract from a foreign work, comprised in a very small space". It bears the name of "Dr Farr's Elements, &c and first appeared above thirty years ago". In fact that was translated from the 1767 publication Elemental Medicinae Forensis by Fazelius of Geneva. Davis [14] refers to these and to Remarks on Medical Jurisprudence by William Dease of Dublin, as well as the Treatise on Forensic Medicine or Medical Jurisprudence by O. W. Bartley of Bristol. Davis considered however that the "first original and satisfactory work" was George Male's Epitome of Juridical or Forensic Medicine, published in 1816. Male was a physician at Birmingham General Hospital and is often considered the father of English Medical Jurisprudence. Smith refers also to Male's book but also comments "to which if I may add a 'Treatise on Medical Police', by John Roberton, MD".

Texts on forensic medicine began to appear more rapidly and with much broader content. John Gordon Smith [12] stated that "Forensic Medicine – Legal, Judiciary or Juridical Medicine – and Medical Jurisprudence are synonymous terms". Having referred in the Preface to the earlier books, he notes, "It is but justice to mention that the American schools have outstripped us in attention to Forensic Medicine". By this he was probably referring in part to the writing of Theodric Romeyn Beck and others. Beck published the first American textbook 2 years later in 1823 and a third (London) edition had been published by 1829 [11]. Prior to this, in 1804 J. A. Stringham, who was trained in Edinburgh being awarded an MD in 1799, was appointed as a Professor in Medical Jurisprudence at the College of Physicians and Surgeons of New York and given a Chair in 1813.

John Gordon Smith [12] wrote that "Every medical practitioner being liable to a subpoena, should make it his business to know the relations of physiological and pathological principles to the facts on which he is likely to be interrogated, and likewise the principal judiciary bearings of the case. The former of these are to be found in works on Forensic Medicine; the latter in those on Jurisprudence". Alfred Taylor [15] in "A Manual of Medical Jurisprudence" defined medical jurisprudence as "…that science, which teaches the application of every branch of medical knowledge to the purpose of law".

There was a clear demand for such books and Traill initially published in 1834 [16] and subsequently in1840 [5] when Regius Professor of Jurisprudence and Medical Police at Edinburgh an "Outlines of a Course of Lectures on Medical Jurisprudence". The first Chair of Forensic Medicine had been established in the UK in Edinburgh in 1803 – the appointee being Andrew Duncan, Junior, (although Andrew Duncan Senior had lectured there on forensic medicine topics since 1789 [17]). Subsequent non-professorial academic forensic medicine posts were set up at Guy's Hospital and Charing Cross Hospital, London. "Principles of Forensic Medicine" by William Guy [18], Professor of Forensic Medicine at King's College, London was published in 1844. At a similar period (in 1839 and 1875 respectively), academic chairs of medical jurisprudence were created in Glasgow and Aberdeen [19] emphasizing the importance of Scottish universities to the development and awareness of forensic medicine and medical jurisprudence.

Over these periods, the relevant areas of interest to forensic medicine and medical jurisprudence were gradually becoming much better defined.

Thus, by the end of the nineteenth century, a framework of forensic medicine that persists today had been established in Europe, the UK, America, and related jurisdictions.

Contemporary Clinical Forensic Medicine

The following working definition has been suggested: "…clinical forensic medicine includes all medical [healthcare] fields which may relate to legal, judicial and police systems" [20]. Even though medicine and law interact much more frequently in cases of living individuals, forensic pathology has long been established as the academic basis for forensic medicine. It is only in more recent years that research and academic interest in clinical forensic medicine has become an area of much more focused research.

In many respects this has been helped by much greater awareness of abuses of human rights and civil liberties, which has directed attention to the conditions of detention of prisoners and to the application of justice to both victim and suspect. The care of detainees is one of the major difference in roles between FPs and forensic pathologists, and a number of bodies nationally and internationally have reinforced the duties of doctors involved with detainees in this setting, variously emphasizing the duties of consent and confidentiality, and their responsibilities to the individual (not the state, or government or body for whom they may be acting or employed by). Guidelines have been published addressing the nature and delivery of such care [21–25]. There are many examples of injustice as a result of doctors and other healthcare professionals unaware of or failing to observe basic human rights or rights enshrined in statute. Such lack of knowledge or failure of medical professionals may be considered at least poor performance and at worst criminally negligent. The death of Steve Biko in South Africa, the conviction of Carole Richardson in England and the deaths of native Australians in prison are widely publicized instances of such problems. The conflicting needs and duties of those involved in the judicial system are clear, and it is sometimes believed that recognition of such conflicts is "new knowledge", which would be naïve and wrong. In England and Wales, the Human Rights Act 1998 – enacted in 2000 – whose purpose is to make it unlawful for any public authority to act in a manner incompatible with a right defined by the European Convention of Human Rights – reinforced the need for doctors to be very aware of those human rights issues that touch on prisoners and that doctors can influence. It is worth noting that it took 50 years after publication of the European Convention of Human Rights and Fundamental Freedoms for that law to be enacted in England and Wales.

The FP has a number of roles that may interplay when assessing a prisoner or someone detained by the state or other statutory body. Three facets of medical care that may conflict have been identified: first, the role of medico-legal expert for a law enforcement agency; second, the role of a treating doctor; and third, the examination and treatment of detainees who allege that they have been mistreated by the police during their arrest, during interrogation or during the various stages of police custody [26]. This conflict is well recognized and not a new concept for FPs. Grant [27] was a police surgeon appointed to the Metropolitan Police in the East End of London, UK, just over a century ago, and recorded the following incident: "One night I was called to Shadwell [police] station to see a man charged with being drunk and disorderly, who had a number of wounds on the top of his head … I dressed them] … and when I finished he whispered 'Doctor, you might come with me to the cell door' … I went with him. We were just passing the door of an empty cell, when a police constable with a mop slipped out and struck the man a blow over the head … Boiling over with indignation I hurried to the Inspector's Office [and] told him what had occurred". Dr. Grant records that the offender was dealt with immediately. Dr. Grant clearly perceived that he had moral, ethical and medical duties to his patient, who was in this case the prisoner.

Dr. Grant was one of the earliest "police surgeons" in England, the first "Superintending Surgeon" having been appointed to the Metropolitan Police Force on 30 April 1830. The Metropolitan Police Surgeons Association was formed in 1888 with 156 members. In 1951, the Association was reconstituted as a national body under the leadership of Ralph Summers, so that improvements in the education and training for clinical forensic medicine could be made [28]. The Association of Forensic Physicians (formerly the Association of Police Surgeons) in the UK remained the leading professional body of FPs worldwide, until the formation of a new Faculty of the Royal College of Physicians – the Faculty of Forensic and Legal Medicine (FFLM) (www.fflm.ac.uk) in 2006.

The Royal Commission on Criminal Justice in 1993 raised concerns about the lack of quality control of doctors working in the field of clinical forensic medicine [29]. Legislation in England and Wales, the Police and Criminal Evidence Act 1984, resulted in an enhanced role for the doctor [30]. Since the publication of the Royal Commission's report there have been repeated calls for a high quality professional medical service to assist the criminal justice system [31–33].

In 2005, the Royal College of Physicians established the FFLM [34] which represents FPs, medico-legal advisers (to medical defence organizations) and medically qualified coroners.

The inaugural meeting was held in April 2006 and objectives confirmed [35]:

> to promote for the public benefit the advancement of education and knowledge in the field of forensic and legal medicine; and
> to develop and maintain for the public benefit the good practice of Forensic and Legal Medicine by ensuring the highest professional standards of competence and ethical integrity.

For many of its members, those objectives will be best served by a properly regulated specialty of clinical forensic medicine, subject to appropriate clinical governance and standards. In March 2009, the then Home Secretary of the UK Government stated "Guidance as to the level of professional and clinical qualification required for doctors or nurses is issued by the [FFLM]…. Responsibility for recruitment of healthcare professionals is a matter for individual chief police officers, and it is for each police force to make a decision on an individual basis against this guidance…. The FFLM will have an opinion as to what duties should, or should not, be performed by staff at each level in each professional role. There is no mandatory guidance from the police service" (http://www.publications.parliament.uk/pa/cm200809/cmhansrd/cm090318/text/90318w0006.html). The FFLM has published a document "Quality Standards in Forensic Medicine", which recommended certain standards for those working in general forensic medicine and sexual offence medicine [36].

Global Clinical Forensic Medicine

Table 1.3 is a summary of responses to a questionnaire on various aspects of forensic medical issues sent in 2007–2008 to a variety of specialists in a sample of countries and jurisdictions as with earlier surveys in 1997 and 2003 [37, 38]; it shows the close link between clinical forensic medicine and forensic pathology and how they inter-relate in many different ways. The regulation of the clinical aspect of forensic medicine remains much less defined than that of forensic pathology, despite there being many more practitioners in clinical forensic medicine. This lack of internationally regulated standards may result in poor practice and lower standards of practice.

It is essential that doctors working in the field are properly trained [39–41]. A review of complaints against FPs and other healthcare professionals within the UK showed how difficult it is to identify poor performance, simply because the data are not appropriately recorded by the respective healthcare regulators [42]. Table 1.3 also addresses key questions as to how important aspects of such work – including forensic assessment of complainants and investigations of police complaints and deaths in custody, and age assessments – are undertaken. In the previous editions of this book, the following comments were made about clinical forensic medicine – the italicized comments represent apparent changes that had been noted between the 1997 and 2003 surveys. Review of these comments in the light of the 2007/2008 survey suggests that there are no additional substantial changes.

No clear repeatable patterns of clinical forensic medicine practice may be seen on an international basis – *but there appears to be an increase in recognition of the need to have appropriate personnel to undertake the roles required.*

Several countries have informal/ad hoc arrangements to deal with medical and forensic care of detainees and victims – *this still remains the case – often with large centres having physicians specially trained or appointed whilst rural or outlying areas are reliant on non-specialists.*

Table 1.3 Responses to questions related to forensic medicine issues from a sample of countries (note that these responses apply to the date of the survey ~ March 2008)

Question	Australia	Canada	Dubai	England & Wales
Is there an established system in your country (or state) by which the police and judicial system are required to get a medical assessment of individuals who are detained in police custody (detainees/ prisoners)?	No – Individuals are assessed in custody only at the request of either a member of the police force or judicial system There is no legislative basis for assessment of police prisoners in Victoria. There is a nurse stationed at or visiting the police stations where 80% of detainees are housed and every new prisoner is offered a nurse based assessment. The nurse will call a doctor as required	No	Yes Federal Act (43/1992) for organizing penal institution, Articles 29-33	Yes – The Police & Criminal Evidence Act publishes Codes of Practice
Who examines or assesses individuals detained in police custody to determine whether they are medically fit to stay in police custody?	Medical practitioner - occasionally a nurse may undertake this assessment See above	Emergency room physician, if disputed	There is a police clinic attached to prisons where prisoner and detainees are examined and treated if they become ill while in prison including different specialties and dentistry	Healthcare professionals including doctors nurses and paramedics under a variety of contractual arrangements
If a prisoner is suspected of being under the influence of drugs and/or alcohol in police custody, is it usual for them to be examined by a doctor (or other healthcare professional -if so, specify) to determine whether they are fit to be detained in custody?	A) If the person has been apprehended for public drunkenness there is No routine assessment at the moment. Legislation to change this maybe introduced in parliament before the end of 2007. "Drunks" who cause police any concern are bailed and transferred to hospital under standard operating procedures B) If the person is on remand or awaiting prison transfer, then they will be assessed	Yes – same reason	Yes – usually examined by the a physician from the prison clinic, who can refer them to a specialist or a hospital if necessary	Yes – Could be a doctor, nurse or paramedic

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Table 1.3 (continued)

Question	Australia	Canada	Dubai	England & Wales
If a prisoner is suspected of having swallowed any illicit drugs just before or whilst in police custody, are there any guidelines as to how these prisoners should be managed?	They are either observed in an environment that has 24 hour nursing with medical backup or transferred to hospital	Yes – same reason	The physician from the prison clinic is called and he decides whether to refer him to the hospital or not (according to each case)	Yes – It is advised that any prisoner suspected of swallowing must be transferred to hospital for assessment
If a prisoner in police custody is suspected of having drugs concealed per rectum or per vaginam, are there any guidelines as to how these prisoners should be managed?	An intimate search can be undertaken with consent only by a doctor and in an appropriate clinical setting	Yes – same reason	The prison clinic and the police clinic have facilities to undertake Ultrasound Examination to detect foreign bodies, and that will be followed by intimate search depending on the result of the ultrasound	Yes – Guidelines of care have been produced and are updated regularly. All such searches must be undertaken with consent in settings with resuscitation facilities
Does your country/state have specific codes/laws/statutes or regulations that allow for the immediate health needs of individuals in police custody? If possible can you give a reference for where such regulations/laws may be obtained?	There is no legislative equivalent of PACE in Victoria. As a matter of police policy everyone in police custody is entitled to appropriate health care. The Custodial Medicine Unit coordinates the health care of prisoners across the state. The unit employs 12 nurses (8 full-time and 4 part-time) and has a network of doctors on call, some of whom are also forensic physicians	I do not know, but I expect it is covered by our *Charter of Rights and Freedoms*	Yes – Federal Act (43/1992) for organizing penal institution, Articles 29-33	Yes – Police & Criminal Evidence Act 1984

Who normally undertakes the forensic medical examination and assessment of alleged *victims* of sexual assault?	For adults: Forensic physicians and, if available, a panel of female medical practitioners who have varying levels of expertise. There are moves towards the introduction of nurse examiners, although this has yet to be achieved Children: Forensic physicians and paediatricians specifically within the Victorian Forensic Paediatric Medical Service	Nurse	The forensic medical examiners	Predominantly doctors with a very small number of nurses
Who normally undertakes the forensic medical examination and assessment of alleged *perpetrators* of sexual assault?	Forensic physicians	Not done in Ontario	Forensic Medical Examiners	Doctors, nurses and paramedics
In cases of sexual assault is it always possible for victim, perpetrator or both to be examined by a doctor of the same gender if that is requested?	Yes – if at all possible. In cases where a female doctor is requested and if a female examiner with forensic experience is not available, arrangement is sometimes made for a forensically untrained medical practitioners, to conduct the examination under the direction of an experienced forensic physician	Mostly yes	Yes – as we have female FME to undertake examination in such cases	No

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Table 1.3 (continued)

Question	Australia	Canada	Dubai	England & Wales
Who undertakes the forensic medical examination and assessment of child victims of *sexual* assault?	Specific group of paediatricians and selected forensic physicians	'Forensic' paediatricians at the teaching hospital for children. These doctors are designated by experience rather than training or qualification. No substantive forensic medical involvement is actually had in our system	Forensic Medical Examiners	Preferably a joint examination with a forensic physician and a paediatrician
Who undertakes the forensic medical examination and assessment of alleged child victims of *physical* assault/non-accidental injury – without a sexual element?	These examinations are usually undertaken by the paediatric registrars in the emergency department in conjunction with the On-call paediatric consultants. In some cases depending on the nature of the case, an outpatients clinic is run on a daily basis at both the Monash Medical Centre and Royal Children's Hospital where forensic matters can be addressed	As above	Paediatricians and forensic medical examiners	Paediatricians and forensic physicians

Is there a system in your country/state whereby individuals detained in police custody who appear to have (or have) psychiatric disorder or mental health problems or learning disability – may be assessed?	a) If the person is not a prisoner, then a forensic physician will generally undertake the preliminary assessment - depending on the outcome and availability of the local psychiatric crisis assessment team and other mental health facilities, the person may be referred to a psychiatric hospital or outpatient service. b) If the person is a prisoner (on remand or sentenced) the assessment will be done by a custodial doctor or nurse. Treatment can be provided whilst the person is in police custody if required. The Custodial Medicine Unit liaises with the prison service to have the person transferred to a forensic psychiatric unit if required and ensure that appropriate follow-up care is provided	Yes – under the same ad hoc basis as any health concern for a detainee	The prison doctor undertake the preliminary examination and assessment, and then the person is referred to the psychiatrist attached to the department of health	Yes – The Police & Criminal Evidence Act 1984
In your country/state are there specialised units or locations where victims of sexual assault are examined or assessed?	Yes – These centres are located in Melbourne in 3 specific hospitals. In rural areas they tend to be undertaken either in the doctor's surgery or the local district t hospitals	Yes – the children's hospital and the local women's hospital	They are taken to the hospital by police for treatment, and later a forensic medical examiner is called to perform a medico-legal examination	Most of the 43 England & Wales police services have Sexual Assault Referral Centres
In cases of alleged assault by police who examines *the police personnel*?	Forensic physicians, a hospital or the individual's private practitioner	Emergency (A&E) physician	The police clinic's physicians and later the forensic medical examiner	Doctors, nurses or paramedics

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Table 1.3 (continued)

Question	Australia	Canada	Dubai	England & Wales
In cases of alleged assault by police who examines *the complainant*?	Forensic physicians	Emergency (A&E) physician	Primarily by the police clinic and later by the forensic medical examiner	Doctors, nurses and paramedics
In your country/state – is there a person, a body or an organisation that investigates complaints against the police?	Yes – the Ethical Standards Department (ESD) of the Victoria Police does routine investigations. Their work is overseen by the State Ombudsman, who is an independent judicial officer. There is a separate Office of Police Integrity (OPI) that undertakes independent investigations into allegations of systemic corruption	Yes – The Special Investigation Unit (SIU), a quasi-governmental airs length body of investigators directed by a seconded crown prosecutor	Yes – the public prosecution	Yes – The Independent Police Complaints Commission
If your country has a person, a body or an organisation that investigates complaints against the police, a) is it completely independent of the police?– and b) who funds it?	a) ESD investigate most complaints with oversight as discussed and is part of the police service; the OPI investigate issues of systemic corruption and are independent although the investigators are seconded or former police b) Government.	a) Yes b) Government	a) Yes b) Government	a) Yes – the Independent Police Complaints Commission b) Government
In your country/state, is there a person, a body or an organisation that investigates deaths of individuals whilst in police custody?	Yes – the Homicide Squad undertakes the primary investigation with oversight from ESD, the coroner and the Ombudsman	Yes – the SIU	Yes – The public prosecution	Yes – the Independent Police Complaints Commission – and all such deaths will be subject to inquests by a coroner
If the answer to the above is Yes – a) is that person, body or organisation independent of the police, and b) who funds that organisation?	a) The investigators are not independent but the oversight is b) Government	a) Yes b) Government	a) Yes b) Government	a) Yes b) Government

In your country/state are statistics published about *all* deaths that have taken place in police custody?	Yes	Yes	Only as part of the annual report of the department of forensic medicine or the department of penal institutions	Yes
If the answer to the above question is Yes – where, when and how often are those statistics published and do they include an analysis of cause of death (eg self-harm, drugs, other violence)? Additionally can you provide a) the number of police custodial deaths per annum for the last documented year and b) if available can you give an indication of where that report or figure has been obtained from	Published annually in the reports of the police, coroner, Ombudsman and OPI	1. Yes 2. 22 3. SIU annual report		Yes Approximately 40 (from the Independent Police Complaints Commission)
Does your country/state have a recognised (recognised by your medical professional body) specialty or sub-specialty of medicine for those working in a) *clinical forensic medicine or* b) *forensic pathology?*	a) No b) Yes	a) No b) No (soon it will)	a) No b) No	a) No b) Yes
If the answer to the above is Yes – can you supply me with the details (a) of the main organisation that represents the interests of such practitioners and (b) the number of practitioners represented?	a) Australian College of Legal Medicine - approx 40). Royal Australian College of Pathologists - number uncertain b) See answer to (a)		a) Faculty of Forensic & Legal Medicine of the Royal College of Physicians – approx 700 b) Royal College of Pathologists – approx 50	

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Table 1.3 (continued)

Question	Australia	Canada	Dubai	England & Wales
Can you give a rough estimate of (a) the population of your country/state, (b) the number of medical practitioners working in *clinical forensic medicine,* (c) *forensic pathology?*	a) 4M. b) Approx 40 c) Approx 10	a) 11.5 million (province of Ontario) b) 0 c) Full-time forensic pathologists = ~10	a) About one million b) 6 doing both clinical forensic medicine and forensic pathology	a) 60 million b) ~500 c) ~ 50 (some pathologists also undertake some clinical work)
Are specific qualifications available for (a) clinical forensic medicine or (b) forensic pathology?	a) Yes – Graduate Diploma in Forensic Medicine. DMJ is also accepted and was, until the Monash University Graduate Diploma was devised. The Australian College of Legal Medicine is designing a new faculty examination for entry. b) Forensic pathology – Yes – Fellowship of the Royal Australian College of Pathologists	a) Not in Canada b) Not in Canada	a) Not in the UAE b) Doctors with specialist status have obtained their qualifications elsewhere	a) No b) Yes
Are such qualifications mandatory in order to practice in (a) clinical forensic medicine or (b) forensic pathology?	a) No b) Yes	a) No b) No	a) No only MB ChB, but postgraduate qualifications are favourable when choosing applicants for the jobs b) No	a) No b) Yes
If there is a legal need for age estimation, a) who does it and b) what techniques are used?		a) ad hoc decision. If alive, radiologist, if dead, combination Alive: bone age xray; dead; combination	4. The Forensic Medical Examiner 5. A combination of clinical examination and radiological examination (including dental examination)	

Is there an established system in your country (or state) by which the police and judicial system are required to get a medical assessment of individuals who are detained in police custody (detainees/prisoners)?	There is a law (Laki poliisin säilyttämien henkilöiden kohtelusta 29.9.2006/841; = "*Act on treatment of individuals detained in police custody*") that regulates the treatment of individuals who are detained in police custody	Yes – there is a Code of Practice detailing when a healthcare professional should be called to examine a prisoner or a retained person (police custody, waiting zone for foreigners)	Yes – there is a law with codes of practice for the police officers	Yes – There is a mandatory requirement for medical assessment for detention by the Correctional Services but not for detention by the police. This will be performed by prison doctors. In police detention, medical assessment is performed in the event of noticeable injuries and/or complaints made by arrested person. The assessment are often made by A&E doctors. Occasionally, assessment made by trained forensic doctors
Who examines or assesses individuals detained in police custody to determine whether they are medically fit to stay in police custody?	In most cases a GP of local municipal health centre seldom a forensic doctor	Normally, a medical doctor, sometimes a forensic doctor, always a MD	Only physicians. In Hamburg usually physicians from the Institute of legal medicine plus a few external physicians	A&E doctors mostly, but occasionally forensic doctors

(continued)

Table 1.3 (continued)

Question	Finland	France	Germany	Hong Kong
If a prisoner is suspected of being under the influence of drugs and/or alcohol in police custody, is it usual for them to be examined by a doctor (or other healthcare professional -if so, specify) to determine whether they are fit to be detained in custody?	Yes – if there is concern about their clinical condition or there are other issues such as head injury, or the diagnosis is unclear they will be examined, in most cases, by a GP of local municipal health centre or seldom a forensic doctor or taken to a local hospital. In Helsinki there is a 24-hour clinical forensic medical service at the Department of Forensic Medicine	It is obligatory (MD), at least one examination per 24 hours, police or subject may ask more examinations	Yes – alcohol, drugs and other health conditions that need to be examined by a physician	Yes – invariably they will be sent to the A&E Department of a nearby hospital. If they need to be detained whilst under the influence they are often kept in "Custodial Wards" in the hospital where regular hospital doctors on call looks after them
If a prisoner is suspected of having <u>swallowed</u> any illicit drugs just before or whilst in police custody, are there any guidelines as to how these prisoners should be managed?	As above	They must be immediately transferred to hospital for assessment (xray, CT scan, clinical examination)	There had been a policy in the city state of Hamburg that the drugs would be forcefully excorporated by the use of medications. The European Court has assessed this to be a violence against human rights recently. Now there has to be consent to the excorporation or police provide toilet rooms for the prisoners	Again, they will be sent to the A&E Department of a hospital. Police will probably convince the doctors to keep him warded for "observation"
If a prisoner in police custody is suspected of having drugs concealed per rectum or per vaginam, are there any guidelines as to how these prisoners should be managed?	As above	Yes – an initimate search can be undertaken <u>with consent</u> by a doctor but must be done in an hospital. A police officer **cannot** undertake an examination without consent in France	Same thing in Germany	Yes – there are intimate search procedures. However, most doctors in Hong Kong would refuse to do a search without consent. Again, they are likely to be put under close observation in a custodial ward

Does your country/state have specific codes/laws/statutes or regulations that allow for the immediate health needs of individuals in police custody? If possible can you give a reference for where such regulations/laws may be obtained?	Yes – the act mentioned above http://www.finlex.fi/fi/laki/ajantasa/2006/20060841 unfortunately only in Finnish or Swedish language	Yes – I think you will find the answer in the attached file concerning this subject. We worked on this document	I'm afraid if there is one I don't know it…	No equivalent of PACE, however, there are internal operational police guidelines
Who normally undertakes the forensic medical examination and assessment of alleged *victims* of sexual assault?	In rural areas a GP, in cities mostly a hospital physician at the emergency / paediatric / gynaecology ward, sometimes jointly with a specialist of forensic medicine if available.	Forensic physicians, gynaecologists, paediatricians	In Hamburg, victims of sexual assault are examined by a gynaecologist & a forensic physician at the same time- the gynaecologist collects evidence and does the genital examination, the forensic Physician checks for extra-genital injuries and writes the report	Forensic doctors. A&E doctors are now involved where the victim does not wish to pursue a police report
Who normally undertakes the forensic medical examination and assessment of alleged *perpetrators* of sexual assault?	In rural areas a GP, in cities mostly a hospital physician or a specialist of forensic medicine if available	Forensic physicians	Forensic physicians	Forensic doctors
In cases of sexual assault is it always possible for victim, perpetrator or both to be examined by a doctor of the same gender if that is requested?	No for perpetrators – yes – in some areas for victims – but not always	No, not always, depending on the sex of the MDs in the structure. (even for victims)	Sometimes for victims but not during on-call hours	Not always, although efforts are made to comply. Currently, there is a shortage of female forensic doctors in Hong Kong

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Table 1.3 (continued)

Question	Finland	France	Germany	Hong Kong
Who undertakes the forensic medical examination and assessment of child victims of *sexual* assault?	At University Hospitals increasingly as joint examinations – forensic, paediatric, gynaecology, paediatric surgery, paediatric psychiatry) elsewhere in hospitals by paediatricians or sGPs at municipal health centres	Forensic physicians and/or paediatricians, in some areas a joint examination	Forensic physicians, pediatricians, gynaecologists, usually joint examinations	Forensic doctors and/or pediatricians. Sometimes jointly, but increasingly not
Who undertakes the forensic medical examination and assessment of alleged child victims of *physical* assault/ non-accidental injury – without a sexual element?	At University Hospitals increasingly as joint examinations – forensic, paediatric, gynaecology, paediatric surgery) elsewhere in hospitals by paediatricians	Forensic physicians and/or paediatricians	Forensic physicians and pediatricians	Paediatricians more and more. Occasionally forensic doctors
Is there a system in your country/ state whereby individuals detained in police custody who appear to have (or have) psychiatric disorder or mental health problems or learning disability – may be assessed?	The same laws apply as for any patient with mental health problems	Yes – after a first examination performed by a MD or a forensic practitioners	There are on-call rotas for psychiatrists. Usually the police calls them in the first place	Not really, A&E doctors may refer the cases to Psychiatrists if they can be found!! Occasionally, the police/doctor may initiate a Sectioning Order to have the person detained for 14 days in a psychiatric facility for assessment
In your country/state are there specialised units or locations where victims of sexual assault are examined or assessed?	The victims are examined at a municipal health centre or taken to a local hospital. In Helsinki there is a 24-hour clinical forensic medical service at the Department of Forensic Medicine	Yes – we called them "Unité médico-judiciaire" or "Urgences médico-légales" They are located in certain hospital. In France, each University Hospital has a specialized unit in forensic medicine, with specialized MDs (as I am)	All victims of sexual violence are examined in the gynaecological department of the university medical center	Yes – one run by an NGO. Some efforts to improve hospital based facilities. Most reported incidents examined in forensic doctors facility – within police premises

In cases of alleged assault by police who examines *the police personnel*?	Preferably a forensic specialist but if not available a GP	Forensic practitioners (in France, they are totally independent from the police, and work for an hospital)	Forensic physicians	Forensic doctors in severe cases. A&E doctors in most cases
In cases of alleged assault by police who examines *the complainant*?	Preferably a forensic specialist but if not available a GP	Forensic practitioners	Forensic physicians, gynaecologists	Forensic doctors in severe cases. A&E doctors in most cases
In your country/state – is there a person, a body or an organisation that investigates complaints against the police?	The Parliamentary Ombudsman has the duty to oversee the legality of the actions of authorities and officials and to oversee the legality of various forms of deprival of liberty, such as arrests, remands in custody or imprisonment	Yes – the "inspection générale des services", "la police des polices" or the justice	The complaints are investigated by the department of internal affairs. Forensic physicians do the physical examination	Yes – Complaints Against Police Office which is overseen by the Independent Police Complaints Council
If your country has a person, a body or an organisation that investigates complaints against the police, a) is it completely independent of the police?– and b) who funds it?	a) Yes b) Government	a) Yes – but some of its investigators are former police personnel b) Government	a) No it is within the police b) Government	a) No, it is part of the Police Organisation b) It is funded by the Police.
In your country/state, is there a person, a body or an organisation that investigates deaths of individuals whilst in police custody?	All are subjected to a medico-legal investigation (medico-legal autopsy) ordered by another police district	The Chief Prosecuter of Criminal Court	The prosecution. Our Institute does the autopsies	Yes – The Coroner
If the answer to the above is Yes – a) is that person, body or organisation independent of the police, and b) who funds that organisation?	a) Yes b) Government	a) Yes b) Government	a) Yes b) Government	a) Yes b) Judiciary

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Table 1.3 (continued)

Question	Finland	France	Germany	Hong Kong
In your country/state are statistics published about *all* deaths that have taken place in police custody?	No, only as part of the general mortality statistics but the figures are most probably given in annual statistics by the police	No, I don't think so	I am not sure about that	Yes
If the answer to the above question is yes – where, when and how often are those statistics published and do they include an analysis of cause of death (eg self-harm, drugs, other violence)? Additionally can you provide a) the number of <u>police</u> custodial deaths per annum for the last documented year and b) if available can you give an indication of where that report or figure has been obtained from	Yes – published annually by the Statistics Finland no		My estimation would be about 5-10 cases per year for Hamburg (Autopsies performed at our Institute)	Annually. These deaths are also subject to a public death inquest before a mandatory jury
Does your country/state have a recognised (recognised by your medical professional body) specialty or sub-specialty of medicine for those working in a) *clinical forensic medicine or* b) *forensic pathology?*	a) No b) Yes (the main emphasis of the curriculum of the speciality "forensic medicine" in Finland is in forensic pathology but it includes also training in clinical forensic medicine, however, due to the job structure most specialists practice forensic pathology only.	a) Yes b) Yes	a) Yes b) Yes Both are combined in Germany	a) No b) Yes

If the answer to the above is yes – can you supply me with the details a) of the main organisation that represents the interests of such practitioners and b) the number of practitioners represented?	a) – b) Finnish Medical Association, subsection of forensic medicine ~ 30	a) French Association of Criminology and Legal Medicine: number ? 500+ b) id : number? approximately 30-40 http://www.smlc.asso.fr/	a) Deutsche Gesellschaft für Rechtsmedizin b) ~ 200 (?) in Germany	a) College of Pathologists ~ 18 forensic pathologist/forensic physicians b) See above
Can you give a rough estimate of a) the population of your country/state, b) the number of medical practitioners working in *clinical forensic medicine,* c) *forensic pathology?*	a) 5.2 M b) 0 (full-time) c) ~ 30	a) 60M b) 500–600 not all are affiliated to Faculty c) 20–30	a) 80M b) +c) ~200	a) 7 M b) 18 + 100 (A&E doctors) c) 18
Are specific qualifications available for a) clinical forensic medicine or b) forensic pathology?	a) No b) Yes – a medical speciality called "Forensic Medicine" with 5-year curriculum after graduation from medical school + final written speciality examination co-ordinated for the whole country by the Faculty of Medicine, University of Helsinki	a) 2 major diplomas are available: DESC and Capacité of forensic medicine, both are under Faculty responsibility b) No – forensic pathologists are pathologists with special training (DESC or Capacité)	See above. The system combines Forensic Medicine and Forensic Pathology	a) Yes – the UK DMJ b) Yes – FHKCPath, MRCPath, FRCPA and DMJ There is a structured 6 year postgrad training for forensic pathology with some aspects of forensic medicine. There is a Membership and a Fellowship assessment
Are such qualifications mandatory in order to practice in a) clinical forensic medicine or b) forensic pathology?	a) No b) Yes	a) No, not yet (in progress) b) No	a) Yes b) Yes	a) No b) No, but not having qualifications would mean not recognised as a specialist under legal statutes

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Table 1.3 (continued)

Question	Finland	France	Germany	Hong Kong
If there is a legal need for age estimation, a) who does it and b) what techniques are used?	a) Mixture of radiologist, odontologist, clinical assessment, psychological, social services, anthropologist (dependent on setting) b) Techniques of each of the above	a) Radiologist or forensic physician, rarely forensic radiologist (as I am), or forensic odontologist b) Theorically : clinical examination + radiology (hand and wrist, sterno-clavicular line), teeth examination (we do age estimation this way Frequently and **unfortunately** left hand radiography ALONE		a) It's coordinated by forensic physicians and involves odontologists and radiologists. The summary of the findings is written by the forensic physician b) Clinical examination (forensic physician), plus odontology, if no clear result: radiology in addition

Is there an established system in your country (or state) by which the police and judicial system are required to get a medical assessment of individuals who are detained in police custody (detainees/ prisoners)?	Yes – there is a primary law from 1984 and secondary law of 1987 arising therefrom setting out the custody requirements. However, this law requires updating and further codification. A Working Party is to be established under the Department of Justice, Equality and Law Reform and submissions have been made to that government department	Yes – there is a law with Codes of Practice detailing when a healthcare professional should be called to assess or a body's injury happened	Not in Scotland	For police detention (that may last up to 48 hrs.) there is no established system for medical assessment of individuals. On contrary, for those individuals who are detained on Court order, or these who are serving their sentence in prison, there is established system prescribed in a law (Code of Criminal Sanctions Practice)
Who examines or assesses individuals detained in police custody to determine whether they are medically fit to stay in police custody?	A doctor with experience in forensic assessment drawn from a pool of local General Family Practitioners by arrangement with the local Gardaí Síochana (Police)			If deemed necessary such examination will be performed by local doctors, i.e. those
If a prisoner is suspected of being under the influence of drugs and/or alcohol in police custody, is it usual for them to be examined by a doctor (or other healthcare profes-sional -if so, specify) to determine whether they are fit to be detained in custody?	Yes – if there is concern about their condition or if the prisoner requests, it is the responsibility of the custody Police Sergeant to seek medical assessment			Yes

(continued)

Table 1.3 (continued)

Question	Ireland	People's Republic of China	Scotland	Serbia
If a prisoner is suspected of having swallowed any illicit drugs just before or whilst in police custody, are there any guidelines as to how these prisoners should be managed?	There are no formalised guidelines.			There are no guidelines on that issue, but in such cases the prisoner will be brought to medical attention
If a prisoner in police custody is suspected of having drugs concealed per rectum or per vaginam, are there any guidelines as to how these prisoners should be managed?	There are no formal guidelines in place. This and issue number 4 are now the subject of review of an ad-hoc working group			Detainees has to be searched by the police officers on admission to the detention facility. Police may keep suspects in detention up to 48 hrs. Such detention is in the police station. Following that period of time, the suspect may be further detained only by the Court. Such detainees are transferred to the detention facility within District jail, where they have to be examined by prison doctor on admission
Does your country/state have specific codes/laws/statutes or regulations that allow for the immediate health needs of individuals in police custody? If possible can you give a reference for where such regulations/laws may be obtained?	Yes – Criminal Justice Act 1984 and the Custody Regulations 1987 thereunder. The reference is -http://www.oireachtas.ie/viewdoc.asp?fn=/documents/nav/legislation.htm&m=b			No

Who normally undertakes the forensic medical examination and assessment of alleged *victims* of sexual assault?	There are currently four Sexual Assault Treatment Units in Ireland staffed by Forensic Physicians and Nurses trained in this area. Outside of these units, the Police would rely on an available local doctor with forensic experience. However, the recommendation is to bring the alleged victim to the nearest SATU if possible. This area is currently under a major review and was the subject of an inter-departmental government report in 2006	Gynaecologist
Who normally undertakes the forensic medical examination and assessment of alleged *perpetrators* of sexual assault?	Forensic physicians	Unfortunately, they are rarely examined and assessed forensically
In cases of sexual assault is it always possible for victim, perpetrator or both to be examined by a doctor of the same gender if that is requested?	Yes – in some areas, but not always	Not always
Who undertakes the forensic medical examination and assessment of child victims of *sexual* assault?	Forensic physicians and paediatricians, ideally joint examination. Again, this is an area undergoing reform at present	Pediatricians, and occasionally forensic physicians

(continued)

Table 1.3 (continued)

Question	Ireland	People's Republic of China	Scotland	Serbia
Who undertakes the forensic medical examination and assessment of alleged child victims of *physical* assault/non-accidental injury – without a sexual element?	Usually Paediatricians at A&E Units of Paediatric Hospitals			Pediatricians, and occasionally forensic physicians
Is there a system in your country/state whereby individuals detained in police custody who appear to have (or have) psychiatric disorder or mental health problems or learning disability – may be assessed?	Forensic Physician will generally be called to make assessment. One of the difficulties in Ireland currently is the absence of a formalised and structured FME system. Submissions have been made to the Minister of Justice, Equality and Law Reform in this regard. Response is awaited			Preliminary assessment will be performed by the local health care providers. There is psychiatric department of Central Prison Hospital that will provide further care and treatment if necessary
In your country/state are there specialised units or locations where victims of sexual assault are examined or assessed?	Ther are currently four SATUs. Local Police stations are not equipped with specialised suites for examination			No
In cases of alleged assault by police who examines *the police personnel*?	To my knowledge, this would be carried out by a forensic physician engaged by the Police			Any physician, occasional specialist in forensic medicine
In cases of alleged assault by police who examines *the complainant*?	Forensic Physician (but see 12 above)			Any physician, occasional specialist in forensic medicine

In your country/state – is there a person, a body or an organisation that investigates complaints against the police?	Yes – the recently established independent Garda Síochána Ombudsman Commission (under the Garda Síochána Act 2005)	Yes – there are two instances within the police: a) Police Internal Control and Complaints Service, and b) General Police Inspectorate
If your country has a person, a body or an organisation that investigates complaints against the police, a) is it completely independent of the police?– and b) who funds it?	a) Yes b) Government Exchequer	a) No b) Government
In your country/state, is there a person, a body or an organisation that investigates deaths of individuals whilst in police custody?	Yes– the Coroner (under the Coroners Acts 1962–2005) and the the recently established independent Garda Síochána Ombudsman Commission (under the Garda Síochána Act 2005)	Such deaths would be investigated by Court
If the answer to the above is yes – a) is that person, body or organisation independent of the police, and b) who funds that organisation?	a) Yes b) Coroner (Local Govcernment funding); Garda Síochána Ombudsman Commission (Government)	a) Yes b) State
In your country/state are statistics published about *all* deaths that have taken place in police custody?	I believe that this will now take place under the 2005 legislation	No

(continued)

Table 1.3 (continued)

Question	Ireland	People's Republic of China	Scotland	Serbia
If the answer to the above question is yes – where, when and how often are those statistics published and do they include an analysis of cause of death (eg self-harm, drugs, other violence)? Additionally can you provide a) the number of <u>police</u> custodial deaths per annum for the last documented year and b) if available can you give an indication of where that report or figure has been obtained from	Not yet in place as the Commission commenced its work only in this year, 2007. The information would also be available from individual Coroner's offices. The Department of Justice, Equality and Law Reform has recently sought such information from the relevant Coroners' districts on foot of a Parliamentary Question. I do not have the outcome of this collation but will seek it from the Department			
Does your country/state have a recognised (recognised by your medical professional body) specialty or sub-specialty of medicine for those working in a) *clinical forensic medicine or* b) *forensic pathology?*	a) No b) No			a) No b) Yes (*Please refer to additional comments bellow*)
If the answer to the above is yes – can you supply me with the details a) of the main organisation that represents the interests of such practitioners and b) the number of practitioners represented?	a) A number of forensic doctors (perhaps up to 10 and increasing) in Ireland are Fellows and Members of the Faculty of Forensic & Legal Medicine at the Royal College of Physicians b) There are fewer than six forensic pathologists in Ireland. I believe that they are all members of the British Association of Forensic Medicine			a) CFM – Serbian Physicians Society ~ 5,000+; forensic pathologists (*Please refer to additional comments bellow*) Serbian Association in Forensic Medicine ~ 50 b) (see answer to a)

Can you give a rough estimate of a) the population of your country/state, b) the number of medical practitioners working in *clinical forensic medicine,* c) *forensic pathology?*	a) 4.25 million b) Maybe 30, but it is difficult to be exact as there are about 50 on a list countrywide who make themselves available for forensic police work c) No more than 6 (but of the approximately 5,250 medico-legal post mortem examinations carried out annually, some 250 are performed by forensic pathologists and the remainder by hospital-based pathologists with a special interest in morbid anatomy)	a) 8.5 M b) *Please refer to additional comments bellow* c) ~ 50 specialists in forensic medicine (*please refer to additional comments bellow*)
Are specific qualifications available for a) clinical forensic medicine or b) forensic pathology?	a) Yes- University College Dublin now has a Graduate Diploma in Forensic Medicine (in its 4th year of existence) and has established a Masters programme in Clinical Forensic Medicine commencing this September 2007 b) Through the MRCPath	a) No (*Please refer to additional comments bellow)* b) Yes – there is a training system for forensic medicine
Are such qualifications mandatory in order to practice in a) clinical forensic medicine or b) forensic pathology?	a) No b) No, although recent advertisements for appointment to the State Pathologist's Office have required such higher training	a) No b) Yes (*Please refer to additional comments bellow*)
If there is a legal need for age estimation, a) who does it and b) what techniques are used?	The meaning of this question is not entirely clear to this reader	a) Usually specialist in forensic medicine b) Combination of techniques – clinical examination, odontology, and radiology

(continued)

Table 1.3 (continued)

Question	Spain	SriLanka	Sweden
Is there an established system in your country (or state) by which the police and judicial system are required to get a medical assessment of individuals who are detained in police custody (detainees/prisoners)?	Yes – there is a system in Spain through which any individual detained in police custody has the right to be examined by a doctor (Spanish Health Public National System). If the prisoner has been put under regulation, he has the right to receive forensic assessment (Forensic physicians Corps of the Ministry of Justice). In case of serving a firm sentence in a prison, the prison Institution itself has its own doctors for the prisoner's examination (corps of doctors of Prison)	Yes – there is an established system. It is required by law and codes of practice to examine all detainees/prisoners by medical officers preferably Judicial Medical Officers (JMO) * Clinical forensic medicine and forensic pathology in Sri Lanka are considered as one stream and full time forensic practitioners are referred to as Judicial Medical Officers (JMO)	Yes
Who examines or assesses individuals detained in police custody to determine whether they are medically fit to stay in police custody?	When a person is under arrest (without having being put under regulation)), he asks for being examined by a doctor, he is usually transferred to the Spanish Health Public System doctors. The forensic physician takes part, exceptionally	Always by medical officers; usually by Judicial Medical Officers, occasionally by other medical officers attached to the government hospitals	Usually a forensic pathologist or a physician with specialist training for the task
If a prisoner is suspected of being under the influence of drugs and/or alcohol in police custody, is it usual for them to be examined by a doctor (or other health-care professional -if so, specify) to determine whether they are fit to be detained in custody?	Yes – he is often to be examined and even blood samples to be extracted (with his previous consent) if the prisoner is involved in some aggression, homicide or car driving, for example	Yes – they will be examined by a doctor with a view to necessary management	No, not normally, unless the person is injured or suffering from some medical condition or there is special concern about the clinical state of the person concerned If necessary a blood specimen is taken by force with the police using the force and the physician or registered nurse taking the blood sample

If a prisoner is suspected of having <u>swallowed</u> any illicit drugs just before or whilst in police custody, are there any guidelines as to how these prisoners should be managed?	Yes – they must be immediately transferred to hospital for assessment	Police are instructed to refer these prisoners immediately to the nearest government hospital	Depending on the person's condition after swallowing the drug he or she might be taken to hospital for observation and possibly treated for acute poisoning
If a prisoner in police custody is suspected of having drugs concealed per rectum or per vaginam, are there any guidelines as to how these prisoners should be managed?	Nobody can carry our an intimate search without consent. Nevertheless, a doctor or forensic physician must be alert in feces (for example) or even (exceptionally) by force . Most part of times, the accused gives the consent. A police officer never can undertake an examination by himself, he needs authorization of Judge	No specific guidelines. Police are advised to refer all prisoners to the nearest government hospital or in cities to major medico-legal units	Examination is done by a physician and never by a police officer. The police officer is allowed to collect a specimen of urine with fairly close supervision to avoid attempts at adulteration. Male suspect (male officer), female suspect (female officer)
Does your country/state have specific codes/laws/statutes or regulations that allow for the immediate health needs of individuals in police custody? If possible can you give a reference for where such regulations/laws may be obtained?	Yes – there are specific rules in the Spanish Constitution, in the Penal Code, in the Criminal Law and in the General Law of Prisons	No specific Laws. General recommendations are given in the Police and Prison Ordinances	Yes – by taking the person to a hospital
Who normally undertakes the forensic medical examination and assessment of alleged *victims* of sexual assault?	A forensic physician and gynaecologist if victim in woman	Usually by Judicial Medical Officers who are qualified full time forensic practitioners or medical officers trained in medico-legal work. Otherwise by the senior medical officer at the Out Patient Department of a government hospital. Rarely by an Obstetrician of a government hospital	A forensic pathologist or hospital physician

(continued)

Table 1.3 (continued)

Question	Spain	SriLanka	Sweden
Who normally undertakes the forensic medical examination and assessment of alleged *perpetrators* of sexual assault?	Forensic physicians. An urologist also cooperates exceptionally	Judicial Medical Officers, Medical Officers trained in medico-legal work and Senior Medical Officers of the out patient dept. of government hospitals	As above
In cases of sexual assault is it always possible for victim, perpetrator or both to be examined by a doctor of the same gender if that is requested?	No Neither the forensic physician nor the gynaecologist can be chosen. It depends on the doctor on duty	No Not always; may be possible in major medico-legal units in the cities	Not sure, probably not neither for the victim nor the perpetrator
Who undertakes the forensic medical examination and assessment of child victims of *sexual* assault?	Forensic physicians and pediatricians – ideally as joint examinations	Usually Judicial Medical Officers, sometimes paediatricians	
Who undertakes the forensic medical examination and assessment of alleged child victims of *physical* assault/ non-accidental injury – without a sexual element?	Forensic physicians and pediatricians – ideally as joint examinations	Usually Judicial Medical Officers	A forensic pathologist or a hospital physician
Is there a system in your country/state whereby individuals detained in police custody who appear to have (or have) psychiatric disorder or mental health problems or learning disability – may be assessed?)	Yes – Any individual detained who appears to have symptoms of mental disease immediately is remitted to the judge and is examined by a forensic physician and/or psychiatrist to determine if he must de admitted to a psychiatric hospital. In the same way, if the prisoner serving a sentence, becomes a mental ill person, he is moved to a psychiatric hospital	Yes – They will be referred to a mental hospital or to a psychiatric unit in a major hospital for further management. Initially they may be assessed by Judicial Medical Officers	Yes – in the first instance a forensic pathologist and later a forensic psychiatrist

In your country/state are there specialised units or locations where victims of sexual assault are examined or assessed?	Victims of sexual assault, are examined in Gynaecology or Paediatrics Departments of the big hospitals	Yes – National Child Protection Authority based in Colombo has special facilities for child victims Usually all victims are referred to major Medico-legal units located in teaching, general or base hospitals or to other government hospitals	No, not to my knowledge, examination is done at the nearest hospital with the police providing the examining physician with a "rape-kit" containing tubes etc for biological evidence, DNA etc
In cases of alleged assault by police who examines *the police personnel*?	A forensic physician as member of the Ministry of Justice (completely independent of the Police)	Judicial Medical Officers or other medical officer attached to a government hospital	Don't know. This is very rare in Sweden. On duty or off duty? Off-duty a forensic pathologist would do the examiantion.
In cases of alleged assault by police who examines *the complainant*?	Forensic physicians	Judicial Medical Officers or other medical officer attached to a government hospital	Don't know.
In your country/state – is there a person, a body or an organisation that investigates complaints against the police?	Yes – the Court of instance, that one on duty at the time when the facts are alleged	Yes – Police Commission and Human Rights Commission	Yes – there are ombudsmen (legally qualified people) who investigate complaints made against the police or other state employee.
If your country has a person, a body or an organisation that investigates complaints against the police, a) is it completely independent of the police?– and b) who funds it?	a) Yes – there is b) Government through Ministry of Justice	a) Yes partially; some are retired police officers b) Government	a) Yes with high standing legal qualifications and with help of investigators. b) Central government
In your country/state, is there a person, a body or an organisation that investigates deaths of individuals whilst in police custody?	Yes – the Institutes of Legal Medicine (IML). The ILM are consultant organism of the Ministry of Justice, district Attorney, Judge and Courts	Yes – The magistrate of that area investigates the deaths in custody as required by law	First the police then the crown prosecutors and then if necessary an independent tribunal

(continued)

Table 1.3 (continued)

Question	Spain	SriLanka	Sweden
If the answer to the above is yes – a) is that person, body or organisation independent of the police, and b) who funds that organisation?	a) Yes – totally independent. b) The Judge, the judicial Secretary, the district Attorney and the Forensic physician	a) Yes b) Government	a) Prosecutors are independent from the police in Sweden b) Government
In your country/state are statistics published about *all* deaths that have taken place in police custody?	Yes	Annual Health Bulletin which carries all health statistics of living and dead in Sri Lanka does not have these figures. But they are available with the police department	Probably but I have not seen them
If the answer to the above question is yes – where, when and how often are those statistics published and do they include an analysis of cause of death (eg self-harm, drugs, other violence)? Additionally can you provide a) the number of <u>police</u> custodial deaths per annum for the last documented year and b) if available can you give an indication of where that report or figure has been obtained from	Yes – published annually in the statistics of Institutes of Legal Medicine of different regions and National Committee of Solidarity with Arrested Peoples b) In 2001, 49 peoples. In 2002, 71 peoples In 2003, 63 peoples In 2004, 79 peoples In 2005, 68 peoples	These statistics are maintained by the police department. Hence their accuracy is debatable. b) 10(off hand) – excluding North and east of Sri Lanka	Everything is in the public domain in Sweden if you know where to look or ask for it. I guess that one should write to the National Swedish Police Board (Rikspolisstyrelsen) in Stockholm and ask for the statistics regarding deaths in custody
Does your country/state have a recognised (recognised by your medical professional body) specialty or sub-specialty of medicine for those working in a) *clinical forensic medicine or b) forensic pathology)?*	a) Yes b) Yes The specialty is named "Forensic and Legal Medicine" (Especialidad en Medicina Legal y Forense) and qualify to practice both areas	a) Yes b) Yes In Sri Lanka the work related to both clinical forensic medicine and forensic pathology fields are carried out by Judicial Medical Officers (JMO)	a) Yes – for forensic pathology b) No, because clinical forensic medicine does not exist as a speciality in Sweden

If the answer to the above is yes – can you supply me with the details a) of the main organisation that represents the interests of such practitioners and b) the number of practitioners represented?	a) Forensic physicians are jointed in some professional Associations nationwide like the Asociación Nacional de Médicos Forenses, Asociación Andaluza de Médicos Forenses, Asociación Estatal de Médicos Forenses, Asociación Gallega de Médicos Forenses., b) About 300 forensic physicians are affiliated in those Associations	a) College of Forensic Pathologists Sri Lanka b) ~40	a) The National board of Forensic Medicine, Vasagatan 52, 111 20 Stockholm is responsible for the organization of Forensic Medicine throughout Sweden. b) Forensic medical expertise is located at offices and laboratories at the university hospitals, which are affiliated with cities of Umeå, Uppsala, Stockholm, Linköping, Göteborg and Lund
Can you give a rough estimate of a) the population of your country/state, b) the number of medical practitioners working in *clinical forensic medicine,* c) *forensic pathology?*	a) The population of Spain is about 45 millions b) Currently about 550. c) About 100	a) 19.7 million b) Full time JMO ~ 40 medical officers trained in M-L work ~ 100 c) Full time JMO ~ 40 medical officers trained in M-L work ~100	a) 9 million b) None c) 40–50 (forensic pathologists)

(continued)

Table 1.3 (continued)

Question	Spain	SriLanka	Sweden
Are specific qualifications available for a) clinical forensic medicine or b) forensic pathology?	a) Yes b) Yes The specialty is named "Forensic and Legal Medicine" (Especialidad en Medicina Legal y Forense) and qualify to practice both areas. In addition each forensic physician must to pass a national exam to works on Government	a) Yes b) Yes In Sri Lanka clinical forensic medicine and forensic pathology are practised as one discipline. All full time forensic practitioners must undergo the Diploma in Legal Medicine (DLM) course first and then the MD in forensic Medicine. Both these courses usually take 5 years to complete and after completion they must go overseas for mandatory one year training. They are designated as Judicial Medical Officers (JMO) and usually majority of JMO's possess DMJ	a) No b) Medical degree and specialist training
Are such qualifications mandatory in order to practice in a) clinical forensic medicine or b) forensic pathology?	a) Yes b) Yes	a) No b) No	a) Not relevant b) Yes
If there is a legal need for age estimation, a) who does it and b) what techniques are used?	a) Could be odontologist, forensic physician, odontologist, radiologist, anthropologist. b) May be odontology, radiology, anthropology and/or clinical examination – or a combination		There is an odontologist at the dept. of forensic medicine in Stockholm. Maybe with people entering Sweden from other countries (refugees) political asylum seekers. Don't know the techniques used

The emphasis in several countries appears to be on the alleged victim rather than the alleged suspect – *this remains the case although there are suggestions that this approach is being modified*.

The standard of medical care of detainees in police custody is variable – *there appears to be more recognition of the human rights aspects of care of those in police custody*.

There are no international standards of practice or training – *international standards are still lacking – but more countries appear to be developing national standards.*

There are apparent gaps in the investigation of police complaints in some countries – *this remains the case*.

Death in custody statistics are not always in the public domain – *this remains the case – and the investigation of deaths in police custody may still not be independently undertaken.*

There is, however, now clear recognition of the roles and inter-relationship of FP and forensic pathology, and indeed in many jurisdictions both clinical and pathological aspects of forensic medicine are undertaken by the same individual.

There is an acceptance in some countries for the use of appropriately trained alternate healthcare professionals (e.g. nurses and paramedics) in some settings (notably some aspects of care of detainees in custody) [43]. These additional healthcare professionals must be appropriately trained with regard to their understanding of their professional and ethical positions [44]. This development may be influenced by the nature of healthcare problems of detainees [45] and how such healthcare is delivered [46–48].

There are few full-time academic posts of clinical forensic medicine within first line universities in the UK, and many of the posts that do exist are honorary rather than tenured. This situation is similar in many other countries. Until governments and states recognize the societal importance of appropriate clinical forensic medicine fully funding academic posts with trained and experienced researchers in these posts, then the growth of the discipline will continue to be slow.

In the UK and Europe, much effort has gone into trying to establish a monospecialty of Legal Medicine, and there are some indications that the European Council of Legal Medicine may have begun to make some headway [49].The creation of this specialty on a Europe wide basis would be a great stimulus to FPs and to clinical forensic medicine.

In 2009, the Australasian Association of Forensic Physicians was set up with the aim, among other objectives, of seeking formal recognition of Clinical Forensic Medicine as a medical specialty and the Association have produced a detailed curriculum [50].

There are many Diplomas and Masters degree courses that are appropriate to FPs [51], and the FFLM has recently established an examination for Membership of the Faculty which has the same rigour as other Faculties and Colleges such as the Royal College of Physicians [52]. In the UK, the Society of Apothecaries has created the Diploma on the Forensic and Clinical Aspects of Sexual Assault, aimed at those working predominantly as sexual offence examiners [53].

Conclusions

Several key areas need to be prioritized in clinical forensic medicine:

1. Recognition that clinical forensic medicine is a distinct specialty that requires an appropriate career path. This will necessitate the setting and implementation of explicit quality standards. These standards should include training content, theoretical and practical, including assessment, so that trainees and supervisors in the discipline and other stakeholders know exactly what the minimum standards are [54]. That there is a clear need for a formal structure to the training of FPs [55] and their educational and clinical supervisors has been previously highlighted [56].
2. Recognition that high quality clinical forensic medicine is essential to a society in order that proper justice may be achieved when medical issues are part of the legal process.
3. Recognition that clinical forensic medicine at a senior level should be undertaken by those with specific training in the same way as any other specialty such as cardiology or gastroenterology.

Despite this lack of recognition, clinical forensic medicine continues to develop and when effective supports and enhances judicial systems in the proper, safe and impartial dispensation of justice. Terrorist atrocities, torture and armed conflicts raise issues of human rights at high levels, and these often highlight the work of FPs. FPs should ensure that no opportunity is missed to raise the profile of their work and develop appropriate recognition for the often unthanked and complex roles and tasks undertaken.

References

1. Payne-James JJ, Busuttil A, Smock W (2003) Forensic medicine: clinical and pathological aspects. Greenwich Medical Media, London
2. Payne-James JJ, Smith R, Karch S, Manlove J (2011) Simpson's forensic medicine: 13th edition. Wiley, London
3. Sarkar U, Stark MM (2010) The role of the independent forensic physician. Faculty of Forensic & Legal Medicine, London. http://www.fflm.ac.uk
4. Smith S (1951) The history and development of forensic medicine. BMJ 1:599–607
5. Traill TS (1840) Outlines of a course of lectures on medical jurisprudence, 2nd edn. Adam & Charles Black, Edinburgh
6. Amundsen DW, Ferngren GB (1977) The physician as an expert witness in Athenian Law. Bull Hist Med 51:202–213
7. Amundsen DW, Ferngren GB (1977) Forensic role of physicians in Roman law. Bull Hist Med 53:39–56
8. Brittain RP (1967) Origins of legal medicine. Roman law: Lex Duodecim Tabularum. Med Leg J 35:71–72
9. Amundsen DW, Ferngren GB (1978) The forensic role of physicians in Ptolemaic and Roman Egypt. Bull Hist Med 52:336–353
10. Cassar P (1974) A medicolegal report of the sixteenth century from Malta. Med Hist 18:354–35

11. Beck TR, Darwall J (1829) Elements of medical jurisprudence, 3rd edn. Longman, London
12. Smith JG (1821) The principles of forensic medicine systematically arranged and applied to British practice. Thomas & George Underwood, London
13. Hunter W (1783) On the uncertainty of the signs of murder in the case of bastard children. London. 1821
14. Davis BT (1974) Edward Male, M. D., the father of English medical jurisprudence. Proc R Soc Med 67:117–120
15. Taylor AS (1844) A manual of medical jurisprudence. John Churchill, London
16. Traill TS (1834) Outlines of a course of lectures on medical jurisprudence. Adam & Charles Black, Edinburgh
17. Cordner SM, Ranson DL, Singh B (1992) The practice of forensic medicine in Australasia: a review. Aust NZ J Med 22:477–485
18. Guy WA (1844) Principles of forensic medicine. Henry Renshaw, London
19. Gee DJ, Mason JK (1990) The courts & the doctor. Oxford University Press, Oxford
20. Payne-James JJ (1994) Clinical forensic medicine. J Clin Forensic Med 1:1
21. Stark MM, Rogers DJ, Norfolk GA. Good practice guidelines for forensic medical examiners. Metropolitan Police. November 2001 (Updated every six months). 2nd Ed. November 2004. Last updated November 2008. Also produced for Dyfed Powys Police 2007, Wiltshire Constabulary 2008, Thames Valley Police 2008, Dorset Police 2005, Avon & Somerset Constabulary 2008, Royal Military Police 2009
22. National Centre for Policing Excellence (2006) Guidance on the safer detention & handling of persons in police custody (produced on behalf of the Association of Chief Police Officers and the Home Office)
23. BMA (2009) Healthcare of detainees in police stations: guidance from the BMA medical ethics department and the faculty of forensic & legal medicine
24. UN General Assembly resolution 37/194 Principles of Medical Ethics in the Protection of Prisoners and Detainees Against Torture & Other Cruel, Inhuman or Degrading Treatment, 1982.
25. European Committee for the Prevention of Torture and Inhuman and Degrading Treatment or Punishment (CPT) (2009). http://www.cpt.coe.int. Accessed Dec 2009
26. Editorial (1993) Three-faced practice: doctors and police custody. Lancet 341:1245–1247
27. Grant G (1920) The diary of a police surgeon. C. Arthur Pearson, London
28. Summers R (1988) History of the police surgeon. Association of Police Surgeons of Great Britain
29. The Royal Commission on Criminal Justice (1993) HMSO, London
30. Robertson G (1992) The role of police surgeons. Research Study No 6. The Royal Commission on Criminal Justice. HMSO, London
31. Audit Commission (1998) The doctor's bill. The provision of forensic medical services to the police
32. Norfolk GA, Stark MM (1999) The future of clinical forensic medicine. BMJ 319:1316–1317
33. Home Office (2001) Police leadership and powers unit. Policing and Crime Reduction Group. Report of the Home Office Working Group on Police Surgeons. April 2001
34. Payne-James JJ, Norfolk GA, Seymour C, Burnham R (2006) Forensic and legal medicine – a new faculty: progress at last. BMJ careers 21st January
35. Norfolk GA (2006) New faculty of forensic and legal medicine. Clin Med 6:335–336
36. Stark MM, Wall I (2010) Quality standards in forensic medicine. Faculty of Forensic & Legal Medicine, London. http://www.fflm.ac.uk
37. Payne-James JJ (1997) Questionnaire on 'global clinical forensic medicine,' 4th Annual Clinical Forensic Medicine Postgraduate Conference, Louisville, KY, USA
38. Payne-James JJ (2005) Questionnaire on 'global clinical forensic medicine'. In: Stark MM (ed) Clinical forensic medicine: a physician's guide, 2nd edn. Humana Press, New Jersey
39. Stark MM (2000) The medical care of detainees and the prevention of tragedy – the role of the forensic medical examiner. Clin Risk 7:15–19
40. Wall I (2008) Lack of training in custody medicine in the UK – A cause for concern? J Forensic Leg Med 15:378–381

41. Smock WS (1994) Development of a clinical forensic medicine curriculum for emergency physicians in the USA. J Clin Forensic Med 1:27–30
42. Payne-James J (2010) Clinical risk and detainees in police custody. Clin Risk 16:56–60
43. Randle J, Fewkes S, Stark MM (2010) The role of the healthcare professional. FFLM. http://www.fflm.ac.uk
44. Skills for Health (2007) Functional Map for Healthcare Professionals Working in Police Custody Settings. National Occupational Standards. http://www.skillsforhealth.org.uk/~/media/Resource-Library/PDF/Functional_Map_for_HPC_August_2007.ashx. Last Accessed 12 June 2010 https://tools.skillsforhealth.org.uk/suite/show/id/12. Last Accessed 12 June 2010
45. Payne-James JJ, Green PG, Green N et al (2010) Healthcare issues of detainees in police custody in London, UK. J Forensic Leg Med 17, 11, 2010.
46. Payne-James JJ, Anderson W, Green PG, Johnston A (2009) Provision of forensic medical services to police custody suites in England & Wales: current practice. J Forensic Leg Med 16:189–195
47. Webb V, Stark MM, Cutts A, Tait S, Randle J, Green G (2010) One model of health care provision – lessons learnt through clinical governance. J Forensic Leg Med 17:368–373
48. Skills for Health (2007) National Occupational Standards (NOS) for Healthcare Professionals Working in Police Custody Settings. Case Study. Surrey Police/NHS Trust
49. European Council of Legal Medicine. http://www.eclm.org
50. Australasian Association of Forensic Physicians Inc. (2009) Objectives and Training Curriculum. http://www.vifm.org/cgi-bin/getFramed.cgi?url=http%3A%2F%2Fforensicphysicians.org&back=http://www.vifm.org/contact_us.html. Last Accessed 13 Jan 2010
51. Stark MM (2011) Advice on obtaining qualifications in clinical forensic medicine. FFLM
52. Stark MM, Herring J, Norfolk GA (2009) Examination for membership of the faculty of forensic and legal medicine. J Forensic Leg Med 16:435
53. The Society of Apothecaries of London (2010) Guide to the Diploma in the Forensic and Clinical Aspects of Sexual Assault (DFCASA). March 2010/3. http://www.apothecaries.org. Accessed 22 May 2010
54. Stark MM (2010) The perceptions of how the PMETB Standards are being met in initial on-the-job training in clinical forensic medicine. Thesis submitted for MSC (Medical Education). Royal College of Physicians and University College London
55. Stark MM, Norfolk GA (2009) Training of assistant forensic medical examiners in London, UK. J Forensic Leg Med 17:194–197
56. Stark MM (2009) Principal forensic physicians as educational supervisors. J Forensic Leg Med 16:392–296

Chapter 2
Fundamental Principles

Janet Page and C. George M. Fernie

Introduction

From the time of Hippocrates, doctors have undertaken to practice medicine in accordance with ethical and professional codes of conduct. In addition, as with any other citizen, they are required to comply with the laws of the country in which they reside and practice and must understand the constraints and obligations these may impose on them. Laws will vary from one jurisdiction to another, although there may be some commonality, for example, secondary legislation deriving from European Union law and the influence of English common law on countries of the old Commonwealth. This chapter is written from the perspective of the law in England and Wales and should be read with that in mind.

Recently, in the United Kingdom and elsewhere, many new laws have come into effect that are relevant to medical practice. Ignorance of the law is no defense, and today's doctors are at risk of prosecution for breaches of the law and professional codes of conduct as no previous generation has ever been. With the advent of the internet, patients have become increasingly well informed, have much higher expectations, and are more willing to challenge doctors than their predecessors. Today's doctors are under considerable pressure to keep up to date, not only with advancements in medical practice, but also with changes in the laws governing that practice. It is hoped that this chapter will help to highlight key areas of law doctors should be familiar with, but this can only be an outline. For advice on individual cases or more detailed legal and ethical guidance, doctors are encouraged to approach their Defence Organisation (e.g., MPS, MDU, MDDUS in the UK. Similar arrangements operate in other jurisdictions, e.g., Avant in Australia, MPS in South East Asia, CMPA in Canada) or to refer to guidance from other sources such as the British

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Medical Association and the General Medical Council. For those doctors wishing to pursue a career in Forensic Medicine, the Faculty of Forensic and Legal Medicine (FFLM) offers a higher professional examination (MFFLM) which addresses all the key areas of law relevant to the practice of forensic medicine.

Doctors have a professional obligation to ensure they hold appropriate indemnity. In England and Wales, doctors employed by the NHS are indemnified by the Crown in respect of any claims for negligence arising out of their NHS work. Doctors generally are individually responsible for ensuring they hold appropriate professional negligence indemnity for any work they undertake outside their NHS employment. They should also be aware that individual advice in relation to complaints handling, inquests, disciplinary action (whether by their employer or their regulatory body), and general ethical and professional matters do not fall within the scope of NHS indemnity. All doctors are therefore advised to join an appropriate Defence Organisation to ensure they have access to medicolegal advice and representation whether or not their practice is confined to the NHS.

Ethical Principles

Doctors who practice as forensic physicians (FPs, forensic medical examiners FMEs, forensic medical officers FMOs, or police surgeons) have a special responsibility towards detainees, who, having been deprived of their liberty, are potentially vulnerable and unable to protect their own interests. Although human rights legislation is designed to protect those interests, the FP is in a position to act as advocate on behalf of a detainee and ensure that his or her rights are upheld in accordance with the doctor's professional and ethical codes of conduct. If a doctor has reason to believe these rights are being ignored or abused, he/she may have a duty to raise these concerns with the appropriate authorities.

It is not always appreciated that FPs have two separate roles. In the first instance, they are independent medical assessors of the victims and/or alleged perpetrators of crime, and as such, no conventional therapeutic relationship exists. It is important, therefore, that detainees or victims understand this and the potential ramifications, in order that valid, informed consent can be obtained prior to any examination, being conducted. Second, a therapeutic relationship may arise where advice or treatment is offered to a detainee or victim, but the nature of this relationship will be constrained by the circumstances and the doctor's obligation to pass on relevant information to the police officers responsible for the care and supervision of that individual. This dual accountability has certain parallels with that of occupational health physicians, their employers, and any employees they may be asked to examine or report on. Great care should be exercised when considering issues of consent and confidentiality in such circumstances.

The FP is an integral member of a multidisciplinary team involved in the assessment and care of the victims of crime as well as potential offenders. He/she has a professional requirement to work effectively as part of that team. The elements of effective team working are set out by the GMC in *Good Medical Practice* and include the following: effective communication within and outside the team, a respect for the skills and contributions of others, and an awareness of individual roles and responsibilities and lines of accountability. Doctors also have a professional obligation to participate in audit and team performance reviews and to take steps to remedy any deficiencies identified.

The GMC states that doctors should be willing to participate in the teaching and training of other doctors and students. As with any other professional duty, doctors who take on a teaching commitment are responsible for ensuring they develop the appropriate skills and competencies for the task. They must also ensure that all staff for whom they are responsible are properly supervised and any appraisal or assessments made are honest and objective.

Most of the ethical principles embodied in codes of professional conduct will be familiar to doctors the world over, although they may vary in the detail from one jurisdiction to another. This is the case in relation to guidance produced by regulatory bodies, medical associations, and boards, whereas other codes, for example the European Convention on Human Rights or declarations produced by the World Medical Association, by definition, transcend these geographical boundaries. Doctors should be familiar with the codes of conduct pertaining to the country in which they practice and should expect to abide by them. A breach of professional ethics may lead to disciplinary action against the medical practitioner and may call into question his or her medical registration and hence ability to practice.

Consent

It is a long established principle that an individual of sound mind has the right to determine what will be done with his own body, even if as a consequence of exercising that autonomy his life may be put at risk. This is often referred to as the principle of self-determination and was encapsulated by The House of Lords in its consideration of the seminal case of Airedale NHS Trust v Bland [1]. Lord Keith stated "It is well established English law that it is unlawful, so as to constitute both a tort (a civil wrong) and the crime of battery, to administer medical treatment to an adult who is conscious and of sound mind without his consent. Such a person is completely at liberty to decline to undergo treatment even if the result of his doing so will be that he will die."

This principle applies to mentally competent adults, but what of minors or the mentally incompetent adult? How does the law ensure their interests are protected? Case law has established that in these circumstances it is the doctor's duty to act in the best interests of his/her patient. Determining what constitutes a patient's best interests involves a holistic assessment of the individual's needs in the context of his/her circumstances, values, and beliefs. This can be particularly challenging when dealing with patients who have never had the capacity to express their own views.

In circumstances in which an individual is temporarily incapacitated, for example, as a result of a road traffic accident, the doctor may do what is necessary in these circumstances to preserve life and prevent deterioration of the patient's condition without the express consent of the individual concerned. He/she may, however, do no more, and other less pressing decisions relating to medical care must be deferred until the patient has regained capacity to participate in the decision-making process. The Mental Capacity Act 2005 embodies in statute these common law principles and lays down the framework in which mental capacity is assessed. It goes beyond the common law in that it also makes provision to protect the interests of those without others to speak for them, through the appointment of Independent Mental Capacity Advocates (IMCAs).

Requisites for Consent

It has been established above that any intervention without consent may give rise to criminal and/or civil proceedings against the doctor. The minimum requirement in order to protect against a criminal charge is that the patient should understand in broad terms, the nature, purpose, and effect of the proposed treatment. Any failure to provide sufficient information in relation to the risks or benefits of the proposed treatment would render the doctor potentially vulnerable to a civil claim in negligence. For consent to be deemed valid, the medical practitioner should ensure that he is satisfied that the patient is capable of giving consent, has been sufficiently well informed about what is proposed and therefore able to give a true consent, and has then expressly and voluntarily consented to the proposed course of action. The GMC guidance "Consent: patients and doctors making decisions together" [2] sets out in some detail the professional obligations and good practice considerations with which all UK practicing doctors should be familiar and comply.

Capacity

All doctors must understand the requisites for consent and be capable of determining where this may be in question. In such cases, a formal assessment of capacity should then be conducted as a priority, before any medical intervention is contemplated. This is a situation the doctor is likely to face on a regular basis as a FP. In many cases, you will have the requisite skills to make an assessment of capacity, but in more complex cases you should be prepared to refer your patient for a formal assessment by an independent psychiatrist. In England, this would ideally be a psychiatrist approved under Section 12 of the Mental Health Act 1983 [3]. In a few cases, capacity may still remain in doubt, and in these circumstances, it may be necessary to refer the matter to the courts. The courts will hear such matters as applications for Power of Attorney, for example, where an individual is deemed incapable of managing his or her property and financial affairs.

Understanding Risks and Warnings

There are three separate elements to valid consent, namely, the patient must have capacity, be sufficiently well informed to be capable of understanding that to which he or she is being asked to consent, and give the consent freely and without duress. To satisfy the first of these requirements, the doctor needs to establish that the patient is capable of the following:

1. He or she can comprehend and retain the relevant information.
2. He or she believes that information.
3. He or she can weigh up the information in the balance and arrive at a choice [4].

From this it is clear that valid consent requires more than a signature on a form, and that the latter is of itself, insufficient evidence to mount a successful defense against a civil claim in negligence alleging lack of consent based on a failure to warn adequately. Such claims alleging that risks were not explained or adequate warnings given are arising more and more frequently in medical litigation. It is therefore essential for those seeking consent to spend adequate time explaining the nature and purpose of the proposed investigation or treatment and discussing any risks or adverse outcomes, as well as alternative treatment options available. The standard consent forms produced by the Department of Health provide a useful prompt to those completing them to help ensure that all these issues are considered. The patient's questions about the proposed intervention should be answered frankly and truthfully as was made clear by the courts in the case of Sidaway [5]. The discussions should be undertaken by those with the appropriate knowledge and experience to deal with them, and ideally, the individual who will be performing the procedure.

English law has been slow to follow other common law jurisdictions (e.g., Canada, Australia, and the United States) regarding the nature of the information that must be imparted for consent to be deemed valid. The law has shifted from a paternalistic approach, applying the "reasonable doctor" test based on the Bolam principle of what a reasonable doctor in the circumstances would have told the patient, to a much more patient-focused approach, applying the "prudent patient" test, i.e., what a reasonable patient in those circumstances would want to know. For example, in the leading Australian case [6], the courts imposed a duty to warn of remote (1 in 14,000) but serious complications of elective eye surgery, even though professional opinion in Australia at the time gave evidence that they would not have warned of so remote a risk.

In the United States and Canada, the law about the duty to warn of risks has long been much more stringent. Many US courts recognize a duty on a doctor to warn a patient of the risks inherent in a proposed treatment. In the leading case [7], the District of Columbia appeals court imposed an objective "prudent patient" test and enunciated the following four principles:

1. Every human being of adult years and sound mind has a right to determine what shall happen to his or her body (the principle of self-determination).
2. Consent is the informed exercise of choice and that entails an opportunity to evaluate knowledgeably the options available and their attendant risks.
3. The doctor must therefore disclose all "material risks."
4. The doctor must retain "therapeutic privilege."

A "material risk" was held to be one that a reasonable person, in what the doctor knows, or should know to be the patient's position, would likely attach significance to in deciding whether to forego the proposed treatment- this test is what is known as the "prudent patient test." However, the court held that a doctor must retain therapeutic privilege by which he or she is entitled to withhold from the patient information about risk, which, if disclosed, would pose a serious threat of psychological harm to the patient. In the leading Canadian case [8], broad agreement was expressed with these propositions.

Until recently, English law continued to allow doctors' discretion in deciding what information should be imparted to the particular patient being advised. The cases of Sidaway and Bolitho [9] set the constraints under which this discretion was exercised, namely that the doctors must be supported by a body of medical opinion that is not only responsible, but also stands up to logical and scientific analysis and scrutiny as applied by the courts. In English law, the pendulum has now swung fully in the direction of the "prudent patient," in line with other common law jurisdictions. Furthermore, in Chester v Afshar [10], the House of Lords effectively removed the requirement to prove a causal link between an alleged breach of duty (in this case, a failure to warn of a material risk) and the injury sustained. Hence, if a practitioner fails to warn of such a risk, and that risk eventuates, the practitioner is liable, regardless of whether or not the treatment is carried out negligently. The message for medical and allied healthcare professionals is clear. Medical paternalism no longer has any place where consent to treatment is concerned; patients' rights to self-determination and personal autonomy based on full disclosure of relevant information is the legal requirement for consent.

Voluntary Agreement

Consent given under duress, or where the patient's free choice may be influenced by others or by the circumstances in which the consent is obtained, is not valid. A doctor must be satisfied that a patient's consent is given of his own volition and as an expression of his personal autonomy to exercise his free choice about whether or not to undergo the proposed investigation, procedure, or treatment.

Consent may be implicit or explicit, verbal or written, the validity of each depending upon the circumstances and what is being proposed. Implied consent may be sufficient for some purposes, but not others: for example, a patient holding out her arm in response to a doctor's request to take a blood sample, or measure blood pressure. Where a more complex intervention is proposed, express consent will usually be necessary: for example, consent to undergo surgery. Express consent can be verbal or written. Again, a decision as to what is appropriate will depend upon the circumstances. Although verbal consent is legitimate, the advantage of written consent is evidential. Disputes may arise in the future about the nature and extent of the consent obtained, information given in relation to warnings of side effects or risks, and alternative treatment options. In the absence of a contemporaneous note, the courts will need to decide whose version of events is to be believed, often preferring the patient's recall of a significant life event over and above that of the doctor's recollection of a discussion that took place with one patient among many. Ideally, consent should be taken by the doctor who will be performing the procedure, but at the very least, must be someone with the appropriate level of knowledge and skills to be able to respond appropriately and knowledgeably to any questions the patient may have about what is proposed.

The contemporaneous note should record details of the nature, purpose, and effect of what is proposed, together with information about the relative risks and benefits of treatment, likely success rate and alternative treatment options. For more complex interventions, it may be helpful to supplement these discussions with a printed information booklet or other resource, for example, a CD-ROM which the patient can take away and consider at leisure. Patients should be given time to reflect and discuss what they have been told with loved ones, should they wish to do so. This should be followed up with a further opportunity for the patient to ask questions before finally committing to the procedure.

Particular care should be taken when consent is being obtained in circumstances where the procedure has a forensic rather than a therapeutic purpose, and the doctor is not the patient's usual medical attendant, but may be carrying out tasks that may have a wider implication for the patient, for example, impacting on the liberty of that individual (as a FP), or on his future financial security (in making an assessment for the purposes of a civil claim).

Adult Patients Who Are Incompetent

Until the implementation of the Mental Capacity Act 2005 in England and Wales and the Adults with Incapacity (Scotland) Act 2000, no relative, parent, or guardian had the power to consent to treatment on behalf of an incapacitated adult. No similar power was vested in the courts, either. In 1990, the House of Lords considered a request to sterilize a 36-year-old woman with a permanent mental incapacity and a mental age of 5 years who had formed a sexual relationship with a fellow patient [11]. It was held that no one, not even the courts, could give consent on behalf of an adult who was incompetent. (This followed on from provisions within the Mental Health Act, 1983, removing the parens patriae jurisdiction of the courts in England and Wales. Those jurisdictions in which the courts retain parens patriae still therefore hold the power to provide consent in such circumstances). The House of Lords made it clear that in terms of providing treatment to an adult without capacity, doctors were entitled to act in what they considered the best interests of the patient. In determining the patient's best interests, the doctors were required to act in accordance with a responsible body of medical opinion, i.e., the Bolam principle [12].

The Mental Capacity Act 2005, which came into effect in 2007 in England and Wales, gave statutory effect to these common law principles and to advance directives, or "living wills" as they were more popularly known. Furthermore, the Act introduced a new Power of Attorney, the Lasting Power of Attorney (LPA) to replace the earlier Enduring Power of Attorney (EPA), allowing donors to elect a named representative to make decisions in relation to healthcare matters on their behalf in the event the donor lost capacity to make decisions for himself. The Act also made provision for the appointment of IMCAs to represent the interests of incapacitated adults who have no other friends or relatives to act as an advocate on their behalf.

Minors and Consent

In 1969, the Family Law Reform Act gave minors who had reached the age of 16 years or over the statutory right to consent to treatment without the requirement for the consent of a parent or guardian. The legal position relating to minors less than 16 years was established in the case of Gillick [13]. The House of Lords decided that valid consent could be given by minors under 16 years, provided they understood the issues involved. The particular case in question concerned the provision of contraceptive advice to girls less than 16 years in circumstances in which a parent objected. The House of Lords held that parental rights to determine whether a child under 16 years old received treatment terminated if and when the child achieved a sufficient understanding and intelligence to be able to comprehend the issues involved. The determinant factor is therefore the capacity to understand, rather than the age or status of the individual concerned.

The right of a minor to refuse treatment is much more complex. In order for treatment of a minor under the age of 18 years to be lawful, the consent is required of either the child concerned (if competent) or anyone with parental responsibility (including the courts). When a minor refuses treatment, it may still be lawful to proceed if the doctor has the requisite consent from any other person with authority to give it. Clearly there are practical as well as ethical issues in relation to compelling a minor to undergo treatment against their wishes. The doctor will need to make a judgment as to the relative seriousness of the issue in question and the potential consequences of proceeding or not proceeding with the treatment. In complex cases or where there is disagreement about what is the preferred course of action, it may be necessary to make an application to the courts to resolve this. Case law has shown that, in general, the courts are reluctant to allow a minor to refuse a course of treatment, in consequence of which, his life may be put at serious risk, preferring to err on the side of preserving life, at least until the child in question has attained adulthood at which point he may exercise his right to autonomy to refuse treatment.

Intimate Samples and Intimate Searches

Section 62 of the Police and Criminal Evidence Act (PACE) 1984 provides that intimate samples can only be taken from an individual if authorized by a police inspector (or higher ranking police officer) and if the requisite consent is obtained.

For this purpose, the age of consent is 17 (not 16) years. For young persons between the ages of 14 and 17 years, the consent of both the detainee and the parent or guardian is required, and for those younger than 14 years of age, only the consent of the parent or guardian is statutorily required.

Section 55 of PACE provides that an intimate search of an individual may be conducted on the authority of a police officer of at least the rank of inspector only if there are grounds for suspecting that an individual is hiding on himself or herself an object that might be used to cause physical injury while he is detained or a class A controlled drug. A doctor called upon to conduct an intimate search will be wise to consider carefully whether a detainee is likely to be able to give a free and voluntary consent in such circumstances; an intimate search should not be conducted unless the doctor is thoroughly satisfied that the individual has given valid consent. An intimate search may, exceptionally, be conducted by a doctor if he believes it is necessary to remove a concealed object that is an immediate danger to the life or personal safety of those responsible for the detainee's supervision.

PACE does not apply to Scotland. Where an intimate search is considered necessary in Scotland in the interests of justice and in order to obtain evidence, this may lawfully be carried out under the authority of a sheriff's warrant. As with searches authorized under PACE, however, the BMA and FFLM consider that such searches should be carried out by a doctor only when the individual has given consent [14]. If consent is not given, the doctor should refuse to participate and have no further involvement in the search.

Video and Audio Recordings

The GMC [15] and BMA have issued guidance [16] requiring doctors to inform patients before making a video or audio recording and, except in situations in which consent may be understood by the patient's cooperation with a procedure (e.g., radiographic investigation), to obtain his or her explicit consent. Doctors may make recordings without consent in exceptional circumstances, such as when it is believed a child has been the victim of abuse.

If a recording has been made in the course of investigation or treatment of a patient, but the doctor now wishes to use it for another purpose, for example as a teaching or training aid or in research, the patient's consent must be obtained. Recordings may not be published or broadcast in any form without the explicit, written consent of the patient. Consent is required before recordings are published in textbooks or journals or before they enter the public domain. Consent is required whether or not the patient can be identified from the recording. This is especially so for patients who are mentally ill or disabled, otherwise seriously ill, or children or other vulnerable people. When disability prevents patients from giving informed consent, the GMC advises the doctor to obtain agreement from a close relative or carer; where children lack the capacity to consent, the consent of a parent or guardian is required.

Specific care has to be taken with the recording, storage, and use of intimate images where the FFLM has produced joint guidance with RCPCH on the procedure to be followed in this respect [17].

Recording Telephone Calls

Many countries have laws or regulations that govern the electronic recording of telephone conversations, which are designed to protect individuals' rights. Commonly, a provision will include stating that persons whose telephone calls are being recorded must be informed of that fact – the details of the provision varying from country to country. In the United Kingdom, for example, the Telecommunications Act 1984 requires that the person making the recording shall make "every reasonable effort to inform the parties" of doing so. What constitutes "every reasonable effort" is not defined in the Act, but guidance issued by Ofcom (http://www.ofcom.org.uk) states that reasonable effort may be achieved by the use of warning tones, prerecorded messages, verbal warnings given by telephone operators, or written warnings in publicity material.

A recording may be an invaluable aid for forensic evidence or to help refute a complaint or a claim for compensation, but practitioners who make electronic recordings of telephone calls must be familiar with, and comply with, local laws and codes of practice.

Emergencies

In a medical emergency in which a patient is unable to give or withhold consent as a result of their medical condition at the time (e.g., unconscious patients), and there is no known clear written instruction to the contrary in terms of a valid, extant advance directive made by the patient, treatment that is clearly essential to save life or to prevent serious harm may and indeed should be given. However, non urgent treatment should be deferred until the patient is able to give consent. Patients with longstanding mental incapacity should be given treatment deemed to be in their best interests. Again, in an emergency situation, this should be limited to immediately necessary treatment and nonurgent interventions postponed until a more comprehensive assessment of the patient's best interests can be undertaken.

Confidentiality

> "And whatsoever I shall see or hear in the course of my profession, as well as outside my profession in my intercourse with men, if it be what should not be published abroad, I will never divulge, holding such things to be holy secrets…" [18].

Information acquired by a medical practitioner from or about a patient in the course of his professional work is confidential and should not be released to any third party without the consent of the patient or without proper justification in accordance with professional guidance. This duty of confidence to a patient continues even after the patient's death.

The processing of personal information about an individual is governed by statute. In addition to complying with the law, doctors should also be aware of and follow professional codes of conduct and ethical guidance which may impose additional professional duties on the doctor not required by law. In the UK, the Data Protection Act 1998 makes provision for the handling of personal data about a living individual, including processing, disclosure, storage, and destruction of personal data. Medical information about an individual is classified as sensitive personal data and as such is subject to more rigorous controls. The General Medical Council has recently issued updated guidance entitled "Confidentiality" [19] and "Confidentiality: supplementary guidance" which sets out the professional obligations of a doctor with reference to the statutory framework and gives examples of how and in what specific circumstances breaching a patient's confidence may be justified.

Doctors are responsible for the safekeeping of confidential information obtained in a professional capacity. Information thus obtained from a patient should not generally be disclosed to others without the patient's consent, except in certain specific circumstances. These include where there is a legal duty to do so or where there is an overriding public interest in disclosure, for example, where a failure to disclose the information could put others at serious risk. Most patients would expect information about them to be shared with other healthcare professionals involved in their care, and consent in these circumstances may be implied. Patients may not, however, be aware that information may be shared for other purposes, for example, service planning and financial audit. As a registered medical practitioner, you must be satisfied that patients have access to information about how their details may be used and their right to object. If patient identifiable data are to be disclosed, express consent should be sought and a patient's right to withhold consent should be respected unless disclosure without consent can be justified.

As a general rule, when making a disclosure of confidential information to a third party, only the minimum information necessary to achieve the objective should be disclosed. The doctor should be satisfied that the person(s) to whom the disclosure is made understands and respects that confidentiality.

Death and Confidentiality

The doctor's duty of confidentiality extends beyond the death of the patient. The extent to which information can properly be disclosed after death depends on the circumstances. In general, the consent of the deceased's personal representatives should be obtained before making any disclosure. They should be advised of the purpose of the proposed disclosure and any potential consequences. If in doubt about the appropriateness of making a disclosure relating to a deceased patient, the doctor should contact his defence organisation for further advice. If the doctor is aware of any information held about the deceased that the deceased had previously expressly indicated should not be shared after his death, then these wishes should be respected. Information may also be withheld, if in the opinion of the holder of the record, disclosure would cause serious harm to the mental or physical welfare of another person.

Detention and Confidentiality

A FP should exercise particular care over confidentiality when examining persons who are detained in custody. When taking a medical history and examining a detainee, it is common for a police officer or other detaining official to be in attendance, sometimes in the role of a "chaperone," or possibly simply posted nearby where they can overhear the conversation. Such officials will not owe the detainee a duty of confidence in the same way a healthcare professional does, nor will they be subject to professional sanctions for breaching that confidence.

The doctor called upon to examine a detainee must take great care to ensure that the person being examined understands the role of the FP and the implications for confidentiality. The detainee must understand and agree to the terms of the consultation before any medical information is obtained, preferably by giving written consent.

The examining doctor should do everything possible to maintain the confidentiality of the consultation. It is essential to take the medical history in conditions of strict confidence, commensurate with adequate safeguards against violent behavior by the detainee, and to insist on a neutral chaperone for a physical examination. A police officer who has his own professional duty to record information and events may not be in a position to take on this role.

In the rest of this chapter, only the central issues can be highlighted; local rules and circumstances dictate how these may be resolved in individual circumstances. FPs are advised to refer to the specific guidance available from their professional bodies [20].

Exceptions to the General Duty of Confidentiality

Under certain circumstances, a doctor may disclose confidential information obtained about a patient. For a full consideration of these, please refer to the GMC guidance or equivalent locally relevant guidance. In summary, the main exceptions are set out below in subheadings 3.3.1 to 3.3.5.

With the Patient's Consent

The patient may agree to confidential information about him being shared with others in a number of situations. The most usual of these is where information is shared with other healthcare professionals involved in the care and treatment of the patient. Consent to disclosure in these circumstances may be implied. All doctors in clinical practice have a duty to participate in local clinical audit and in National Confidential Inquiries. Patients should be made aware that their information may be used in this way and that they have the right to object. A patient may also consent to the release of information for employment or insurance purposes, housing and welfare benefits, and references and legal proceedings. In these circumstances, care should be taken to ensure that the patient is aware of the nature and extent of the proposed disclosure and to whom the disclosure will be made and agrees to it. Information may not normally be released to these parties without the patient express consent.

Disclosures Required by Law

You must disclose information about a patient where this is specifically required by law, for example, notification of communicable diseases, industrial diseases and poisoning, and notifications under the provisions of the Abortion Act 1967. As a matter of good practice, wherever practicable, you should inform patients of your obligations and advise them what information will be disclosed and to whom, unless this would undermine the purpose of the disclosure.

There are a number of statutory bodies that have powers to access patients' records as part of their duty to investigate complaints, criminal activities (e.g., fraud), or healthcare professionals' fitness to practice. You should comply with such requests provided you are satisfied that the disclosure is required by law or that it can otherwise be justified. You may wish to ask the relevant body to provide you with details of the statutory requirement on which they are relying and seek advice from your defence organisation if in doubt. Most such statutory bodies will have Codes of Practice which set out how they will access and use personal information. You need to be clear that where information is requested but not required by law, for example, as is the usual case where the GMC are investigating a doctor's fitness to practice, you should seek the patient's consent before disclosure unless you consider the disclosure can be justified in the public interest.

Disclosure of confidential information during the course of judicial proceedings should only be made either with the express consent of the patient, or if the presiding judge directs the doctor to do so. If you are called to give evidence in court and you do not have the patient's consent to release information about them, you should explain this to the judge or presiding officer of the court. The judge will then decide whether the interests of justice in making the disclosure outweigh the patient's interests in keeping the information confidential. You must comply with a direction from a judge to disclose confidential information. Failure to do so may otherwise put you at risk of being held in contempt of court, the penalties for which may include a fine and/or a custodial sentence. Requests for information from the police or solicitors acting on behalf of the patient or a third party normally require the patient's consent, unless the disclosure can be justified in the public interest (see below).

Medical Teaching, Research, and Audit

As a general rule, where possible, patient data used for teaching, audit, or research purposes should be anonymized and express consent should be obtained before identifiable patient data are used in this way. For the purposes of local clinical audit, it is sufficient that patients are made aware their data may be used in this way and of their right to object. Where the purpose of the audit is financial or administrative, express consent should be sought for the disclosure of patient identifiable data. Identifiable information may be disclosed without consent if it is required by law, if it is approved by the Ethics and Confidentiality Committee of the National Information Governance Board under Section 251 of the NHS Act 2006, or if it can be justified in the public interest, and it is either necessary to use identifiable data or it is not practicable to anonymize the information and in either case, it is not practicable to seek consent or efforts to seek consent have been unsuccessful.

Disclosures in the Public Interest

The GMC define the public interest test as follows:

> "Personal information may be disclosed in the public interest, without patients' consent, and in exceptional cases where patients have withheld consent, if the benefits to an individual or society of the disclosure outweigh both the public and the patient's interest in keeping the information confidential." [19]

As with all disclosures made without consent of the patient, the doctor should consider whether the proposed disclosure is necessary for the intended purpose and whether this could be achieved if the information were to be disclosed in anonymized or coded form. Disclosure of identifiable patient information may be justified where a failure to do so could put individuals other than the patient at risk of death or serious harm. Examples would include a disclosure to the DVLA about a patient who continues to drive against medical advice, or who places others at risk by failing to disclose a serious communicable disease. Each case must be judged on its individual merits, and if in doubt, doctors should seek specialist advice from their defence organisation.

Another circumstance in which a disclosure without consent may be justified is to assist the police in the investigation, prevention, or prosecution of a serious crime. Police Officers will often rely on Section 29 of the Data Protection Act to support their request for information. Doctors should be aware that this provision simply protects the person making the disclosure from prosecution for breach of the Act and does not remove the doctor's professional obligation to keep information about patients confidential. The doctor must still be prepared to justify any disclosure made without consent. There is no agreed definition of what constitutes "serious crime," although it is generally accepted that these usually refer to crimes against the person (such as murder, rape, assault) and serious harm to the state or to public order. Crimes against property (with the exception of arson where there may be a risk to life) and financial crimes, unless substantial, are not usually considered to fall into this category. Doctors should also consider the circumstances in which the request is being made. For example, a doctor may be persuaded to release information to assist the police in apprehending a murder suspect who is still at large, and hence, where there is still a risk to the public, but not to release information about a suspect who is already in custody without either the patient's consent or an order from the court.

A patient who is violent or dangerous poses particular dilemmas for the doctor. In the course of a consultation, a patient may tell a doctor that he or she intends to perpetrate some serious harm on another person. Each case must be assessed on its own facts; however, under some circumstances, the doctor may be sufficiently concerned for the welfare of the third party to disclose information to the intended victim or to the police or other person in authority with the power to take appropriate action. Indeed a failure to act in such circumstances could lead to criticism by the court, as happened in the case of Tarasoff [21] in California, in which a specialist psychologist failed to warn the girlfriend of a patient who threatened to kill her, and subsequently carried out the threat. The court determined that while there was no general duty to protect or warn third parties, a special relationship may impose such a duty. In the United Kingdom, a psychiatrist was sued by a patient with a history of violence, for releasing a report about him, prepared at the request of his solicitors in connection with an application for release from detention, without his consent [22]. The psychiatrist advised against release and the patient's solicitors therefore decided not to use the report. The doctor, however, was so concerned about his findings that he released a copy of the report to the relevant authorities, as a consequence of which, the patient's application for release was refused. The patient subsequently filed a civil claim for compensation but this failed, the court holding that the psychiatrist was entitled, under the circumstances, to put his duty to the public above the patient's right to confidentiality.

Duty to Report Gunshot and Knife Wounds

The GMC's recently updated guidance on confidentiality contains supplementary guidance [23] which gives special consideration to dealing with patients presenting with gunshot and knife wounds. It describes a two-stage process in which the police should be informed whenever a patient presents with a gunshot wound or a wound that may have been inflicted by a knife or other sharp instrument, other than self-inflicted wounds or those sustained by accident. Personal information should not be disclosed to the police at this stage. On the attendance of the police, if the patient's clinical condition permits, consent should be sought from the patient for interview. The consequences of a refusal of consent should be clearly explained to the patient, but the patient's decision should nevertheless be respected. Any subsequent decision to disclose information without consent must be justified by the doctor in the usual way, for example, to assist the police in the investigation of a serious crime. The information disclosed should be the minimum necessary to achieve the objective of the disclosure.

Disclosures to Protect the Patient

If a doctor considers disclosure of confidential information is necessary for the protection of the patient, he should explain his reasons for this and encourage the patient to consent to the disclosure. However, a doctor should normally abide by a competent patient's refusal to consent, even if the disclosure leave him or her, but no one else, at risk of serious harm. Disclosure may be justified if it is not practicable to seek consent, for example, where doing so would prejudice the purpose of the disclosure.

Disclosures to Protect Others

Disclosure of identifiable confidential patient information may be justified without consent if in the doctor's judgement, a failure to make the disclosure could put others at risk of serious harm. In these cases, the doctor must weigh the patient's interest in keeping the information confidential against the public interest, or the interests of another individual, in releasing it. This is dealt with more fully in the section on Public Interest disclosures above.

Disclosures About Patients Who Lack the Capacity to Consent

Where a patient is incapable of consenting to disclosure of information about him, either because of a disorder or arrested development of the mind, or because of temporary incapacity for example, unconscious patients, or because the patient is a minor and lacks the maturity to reach a decision, a doctor must either obtain consent from someone with the authority to act on the patient's behalf, or if this is not possible, do what he considers necessary and in the best interests of his patient. For a fuller discussion of those with authority to consent on behalf of minors and incapacitated adults, see the section on consent above. In making an assessment of best interests, the doctor should take into consideration the views of relatives and carers and any previously known wishes of the patient including the existence of a valid advance directive.

Where there are potential child protection/safeguarding concerns, doctors should be aware of their statutory duties under relevant legislation including, for example, the Children Act 1989 and 2004, to make the best interests of the child their paramount consideration and to share relevant information with other agencies. In situations involving vulnerable adults, for example where the doctor is concerned the patient may be the victim of neglect or abuse, and the doctor believes the disclosure is in the patient's best interests and or is necessary to protect others from risk of serious harm, he should pass relevant information promptly to an appropriate authority.

Record Keeping

All doctors should keep objective, factual records of their consultations with patients and of other professional work where the information recorded should be relevant to the purpose for which the note was made. Not only is this desirable per se, but it is also now a professional requirement. Current GMC guidance [24] states that, in providing care, doctors should keep clear, accurate, and legible records, reporting the relevant clinical findings, the decisions made, the information given to patients, and any drugs prescribed or other investigation or treatment. Further, the records should be made at the same time as the events being recorded or as soon as possible thereafter. These standards apply to both paper and electronic records. Where retrospective entries need to be added to the record, these should be clearly recorded as such and dated and timed accordingly. Audit trails allow the exact time an amendment is made in electronic records to be identified and a failure to flag an entry as retrospective could call into question the motivation of the maker of the record.

When handling patient identifiable information there are six fundamental principles (the Caldicott principles) to bear in mind: justification of the purpose of every proposed use, don't use information unless absolutely necessary, use the minimum necessary information, access on a strict need to know basis, all those with access should be aware of their responsibilities and must understand and comply with the law. Particular care must be taken to ensure appropriate measures are in place to ensure confidentiality of electronic records, for example having restricted access levels for different users according to need, password protection, and encryption of portable data, for example, memory sticks. Doctors are encouraged to seek advice on specific issues relating to record keeping from their defence organisation or local Caldicott guardian.

Comprehensive notes assist in the care of the patient, especially when doctors work in teams or partnership and share the care of patients with colleagues. Notes then help to keep colleagues well informed. Good notes are invaluable for forensic purposes; there may be a substantial delay in requests for statements or court appearances. When the doctor faces a complaint, a claim for compensation or an allegation of serious professional misconduct or poor performance, comprehensive notes are invaluable when defending such cases. The medical defence organisations have long explained that an absence of adequate notes may render indefensible which may otherwise have been defensible. The existence of full and accurate contemporaneous notes is often the key to preparing and mounting a successful defense to allegations against a doctor or the institution in which he or she works.

Notes should record facts objectively and dispassionately; they must be devoid of pejorative comment, wit, invective, or defamation. Patients and their advisers now have increasing rights of access to their records and rights to request corrections of inaccurate or inappropriate information.

Access to Health Records

Access to medical and other health records, which is provided for by statute law, varies considerably from one jurisdiction to another. Since the passage of the Administration of Justice Act of 1970, English patients have enjoyed certain rights of access to their medical records for the purposes of a personal injuries claim. The relevant legislation is now contained in the Data Protection Act of 1998, which repealed previous statutory provisions relating to living individuals, governing access to health data, such as the Data Protection Act of 1984 and the Access to Health Records Act of 1990 albeit the 1990 Act remains in force in respect to deceased persons where an individual may have a claim arising out of their death. The Access to Medical Reports Act of 1988 remains fully in force. Unfortunately, space considerations do not permit an explanation of the detailed statutory provisions; readers are respectfully referred to local legal provisions in their country of practice.

The Data Protection Act of 1998 implements the requirements of the European Union Data Protection Directive, designed to protect people's privacy by preventing unauthorized or inappropriate use of their personal details. The Act, which is wide ranging, extended data protection controls to manual and computerized records and provided for more stringent conditions on processing personal data. The law applies to medical records, regardless of whether they are part of a relevant filing system. Besides the primary legislation (the Act itself), secondary or subordinate legislation has been enacted, such as the Data Protection (Subject Access Modification) (Health) Order of 2000, which allows information to be withheld if it is likely to cause serious harm to the mental or physical health of any person, although the normal expectation is disclosure even if the content might be unpalatable to that person.

Guidance notes about the operation of the legislation are available from professional bodies, such as the medical defence organisations. In the United Kingdom, compliance with the requirements of the data protection legislation requires that the practitioner adhere to the following:

- Is properly registered as a data controller.
- Holds no more information about patients than is needed for their medical care and uses it only for that purpose.
- Stores records securely and restricts access to authorized personnel only.
- Complies with patients' legitimate subject access requests access respect to their health records.

Preparation of Reports

Doctors regularly receive requests to produce reports for medicolegal reasons. They should understand the basis for this and what is required – a simple report of fact based on their professional involvement in a case, a condition and prognosis report after a medical examination, an expert opinion, or a combination of these. Although a doctor may possess certain expertise, this does not necessarily mean the court will designate him an expert on every occasion.

A report may be required for a variety of reasons, and its nature and content must be directed to the purpose for which it is sought. Is it a report of the history and findings on previous examination because there is now a criminal prosecution or civil claim? Is an expert opinion being requested based on the clinical notes made by others? Is it a request to examine the patient and to prepare a report on present condition and prognosis? Is it a request for an expert opinion on the management of another practitioner for the purposes of a medical negligence claim?

The request should be studied carefully to ascertain what is necessary and clarification sought where necessary in the case of any ambiguity. The fee or at least the basis on which it is to be set should also be agreed in advance of the preparation of the report. If necessary, the appropriate up-to-date consents should be obtained and issues of confidentiality addressed.

Reasonable care must be taken in the preparation of any report. A medicolegal report may affect an individual's liberty in a criminal case or compensation in a personal injury or negligence action. A condemnatory report about a professional colleague may cause great distress and a loss of reputation; prosecuting authorities may even rely on it to decide whether to bring homicide charges for murder ("euthanasia") or manslaughter (by gross negligence). Reports must be fair and balanced. Any expert should be independent and impartial. The doctor is not an advocate for a cause, but should see his or her role as assisting the court in determining the outcome of a case by clarifying the relevant medical issues. It must always be considered that a report may be disclosed in the course of legal proceedings and that the author may be cross-examined about its content, on oath, in court, and in public.

A negligently prepared report may lead to proceedings against the author, perhaps even referral to the regulatory body and criminal proceedings in exceptional cases. Certainly, a civil claim can be brought if a plaintiff's action is settled on disadvantageous terms as a result of a poorly prepared opinion. There is also the attendant risk of adverse judicial comment and press publicity which may significantly affect that doctor's status in respect to any future instruction.

The form and content of the report will vary according to circumstances, but it should always be well presented on professional notepaper with relevant dates and details carefully documented in objective terms. Care should be taken to address the questions posed in the letter of instructions from those who commissioned it. It is acceptable for the report to be submitted in draft form before it is finalized, but the doctor must always ensure that the final text represents his or her own professional views and must avoid being persuaded by counsel or solicitors to make amendments with which he believes cannot be justified: it is the doctor who will have to answer questions in the witness box which may be felt as the loneliest place in the world if he or she makes claims outside the area of expertise or in any way fails to "come up to proof" (i.e., departs from the original statement).

In civil proceedings in England and Wales, matters have been governed by the Civil Procedure Rules and by a Code of Practice approved by the head of civil justice since 1999. Any practitioner who provides a report in civil proceedings must make a declaration of truth and ensure that his or her report complies with the rules which emphasize his duty to the court.

Attendance at Court

Generally, courts consist of two types: criminal and civil. Additionally, the doctor will encounter the Coroners Court (or the Fatal Accident Inquiry at the Sheriff Court in Scotland), which is, exceptionally, inquisitorial and not adversarial in its proceedings. A range of other special courts and tribunals exists, from ecclesiastical courts to social security tribunals; these are not described here.

It is possible for a doctor to be called to any court to give evidence. The type of court to which he or she is called is likely to depend on the doctor's practice, specialty, and seniority. The doctor may be called to give purely factual evidence of the findings made in the course of his practice, in which case the doctor is simply a professional witness of fact, or to give an opinion on some matter, in which case the doctor is an expert witness. Sometimes, a doctor will be called to give both factual and expert evidence.

Normally, a doctor will receive adequate notice that attendance in court is required and he or she may be able to negotiate with those calling him or her concerning suitable dates and times. Many requests to attend court will be made relatively informally, but more commonly a witness summons will be served. A doctor who shows any marked reluctance to attend court may well receive a formal summons, which compels him or her to attend or to face arrest and proceedings for contempt of court if he or she refuses.

If the doctor adopts a reasonable and responsible attitude, he or she will usually receive the sympathetic understanding and cooperation of the lawyers and the court in arranging a time to give evidence that least disrupts his or her practice. However, any exhibition of belligerence by the doctor can induce a rigid inflexibility in lawyers and court officials – who always have the ability to "trump" the doctor by the issuance of a summons, so be warned and be reasonable.

Evidence in court is given on oath or affirmation. A doctor will usually be allowed to refer to any notes made contemporaneously to "refresh his memory," although it is courteous to seek the court's agreement.

Demeanor in Court

The limited space available does not permit more than to outline good practice when giving evidence. Court appearances should be taken seriously as an individual's liberty may be at risk or significant damages and costs may rely on the evidence given. The doctor's dress and demeanor should be appropriately professional, and he or she should speak clearly and audibly.

Whether it be evidence in chief or cross-examination, it is worth listening attentively to the questions posed. Consider carefully the proposed response prior to putting one's mouth into gear. Answer the question asked (not the one you think it should have been) concisely and carefully, and then wait for the next question. The role of the doctor is not to fill a gap in the conversation; the judge and others will be making notes, and it is wise to keep an eye on the judge's pen and adjust the speed of your words accordingly. Pauses between questions allow the judge to finish writing or counsel to think up his or her next question. If anything you have said is unclear or more is wanted from you, be assured that you will be asked more questions. If there is a straightforward answer, then give it unless the outcome would mislead the court. Brevity has much to commend it, although answering in monosyllables is unlikely to help the court.

Be calm and patient, and never show a loss of temper or control regardless of how provoking counsel may be. An angry or flustered witness is a gift to any competent and experienced counsel, as is a garrulous or evasive witness.

It is perfectly permissible to ask for a question to be repeated as long as this strategy is not repeated ad nauseam.

Try to use simple language devoid of jargon, abbreviations, and acronyms. Stay well within your area of skill and expertise and do not be slow to admit that you do not know the answer. Your frankness will be appreciated, whereas an attempt to bluff or obfuscate or overreach yourself will almost certainly be detrimental to your position.

Doctors usually seek consensus and try to avoid confrontation (at least in a clinical setting). They should remember that lawyers thrive on the adversarial process and are out to win their case, not to engage on a search for truth. Thus, lawyers will wish to extract from witnesses answers that best support the case of the party by whom they are retained. However, the medical witness is not in court to "take sides," but rather to assist the court, to the best of the expert witness' ability, to do justice in the case. Therefore, the witness should adhere to his or her evidence where it is right to do so, but must be prepared to be flexible and to make concessions if appropriate, for example, because further evidence has emerged since the original statement was prepared, making it appropriate to cede points. The doctor should also recall the terms of the oath or affirmation – to tell the truth, the whole truth, and nothing but the truth – and give evidence accordingly.

The Duties of Expert Witnesses

Some medical practitioners have made a career from giving expert opinions, and a few have brought the profession into disrepute by being demonstrably partisan or by giving opinion evidence that is scientifically unsupportable.

The courts have now laid down guidance [25] for expert witnesses; the Academy of Experts and the UK Expert Witness Institute (EWI) have issued a joint code of practice [26] for experts and the General Medical Council issued specific separate guidance entitled Acting as an Expert Witness – guidance for doctors [27].

It is unclear how long after retirement from a specialty a doctor may proffer expert opinions but the GMC document does now stipulate a requirement to keep up to date in that doctor's specialist area of practice and it would seem the longer the time that elapses, the more difficult it will be to maintain credibility in the eyes of the court.

The essential requirements for experts are as follows:

- Expert evidence presented to the court should be seen as the independent product of the expert, uninfluenced regarding form or content by the exigencies of litigation [28].
- Independent assistance should be provided to the court by way of objective unbiased opinion regarding matters within the expertise of the expert witness [29]. An expert witness in the court should never assume the role of advocate.
- Facts or assumptions on which the opinion was based should be stated together with material facts that could detract from the concluded opinion.
- An expert witness should make clear when a question or issue falls outside his or her expertise.
- If the opinion was not properly researched because it was believed that insufficient data were available, that should be stated with an indication that the opinion is provisional. If the expert cannot assert that the report contains the truth, the whole truth, and nothing but the truth, that qualification should be stated on the report [30].
- If after an exchange of reports an expert witness changes an opinion, the change of view/opinion should be communicated to the other parties through legal representatives without delay and, when appropriate, to the court.

The EWI [31] has also produced a declaration for use by experts that follows the form recommended by Lord Woolf, the Chief Justice of England and Wales, in his review of civil justice procedures and that incorporates the legal principles just set out. The EWI Website (http://www.ewi.org.uk) provides an easy route to access several important documents.

In England and Wales, new Civil Procedure Rules for all courts came into force on April 16, 1999 [32], and Part 35 establishes rules governing experts. The expert has an overriding duty to the court, overriding any obligation to the person who calls or pays him or her. An expert report in a civil case must end with a statement that the expert understands and has complied with the expert's duty to the court. The expert must answer questions of clarification at the request of the other party and now has a right to ask the court for directions to assist him in conducting the function as an expert. The new rules make radical changes to the previous use of expert opinion in civil actions.

The GMC guidance explicitly advises on bringing any potential conflict of interest to the attention of the court and specifies that the doctor may continue to act as an expert only if the court decides the conflict is not material to the case.

Pitfalls

There are many potential pitfalls in forensic medical practice and while most may be avoided by an understanding of the legal principles and forensic processes, this is now a topic of postgraduate rather than undergraduate education. The typical "doctor–patient" relationship does not apply; the detainee needs to understand the role of the FP and the relevant explanation provided to ensure any consent is informed in nature.

Meticulous attention to detail and a careful documentation of facts are required at all times. You will never know when a major trial will turn on a small detail that you once recorded (or, regrettably, failed to record). Your work will have a real and immediate effect on the liberty of the individual and may be highly influential in assisting the prosecuting authorities to decide whether to charge the detained person with a criminal offense.

Although a degree of reassurance is provided with the increasing use of custody nurses and paramedics, the doctor may be the only person who can retrieve a medical emergency in the cells – picking up a subdural hematoma, diabetic ketoacidosis, or coronary thrombosis that the detaining authority has misinterpreted as drunkenness, indigestion, or simply "obstructive behavior." Making the correct decision will assist in the proper administration of the judicial process, with the desired regard for human rights and individual's liberty. Getting it wrong may not only fail to prevent an avoidable death, but also may lay the practitioner open to criminal, civil, and disciplinary proceedings.

You clearly owe a duty of care to those who engage your services, for that is well-established law. The issue of whether a forensic physician (FP/FME) owes a wider duty to the victims of alleged crime was decided in the English Court of Appeal during 1999 [33]. A doctor working as an FME examined the victim of an alleged offense of rape and buggery (sodomy). The trial of the accused offender was fixed, and all prosecution witnesses were warned and fully bound, including the FME.

The trial was scheduled to begin on December 7, and on December 6, the FME was warned that she would not be required to attend on the first day of trial but would be needed some time after that. The trial commenced on December 7, and the accused pleaded not guilty. On Friday, December 8, the FME was told that she would not be needed that day but would be required the following week. She did not state that this would cause any problem. However, on December 11, the FME left the country for a vacation. On December 14, the police officer in charge of the case spoke by telephone with the FME. She said she could not return to give evidence before December 19. The remainder of the prosecution case was finished on December 14. The trial judge refused to adjourn the case until December 19. On December 20, the judge accepted a defense submission of no case to answer and directed the jury to return a verdict of not guilty. A few weeks later, the FME was convicted of contempt of court for failing to attend court to give evidence, and she was fined.

The female victim commenced civil proceedings against the FME, alleging negligent conduct in failing to attend, as warned, to give evidence. In her claim, the claimant asserted that if the FME had given evidence (presumably in accordance with her witness statement), the trial judge would have refused the defense submission of no case to answer. The claimant also contended that on the balance of probability, the accused would have been convicted because the FME's evidence would have undermined the credibility of the accused's defense that no anal interference had occurred. The claimant claimed that the FME owed her a duty of care to take all reasonable steps to provide evidence of the FME's examination in furtherance of the contemplated prosecution and to attend the trial of the accused as a prosecution witness when required. She claimed to suffer persistent stress and other psychological sequelae from failing to secure the conviction of her alleged assailant and knowing that he is still at large in the vicinity.

The claimant did not contend that there was any general duty of care on the part of a witness actionable in damages at the suit of another witness who may suffer loss and damage through the failure of the first witness to attend and give evidence in accordance with his or her witness statement.

When the case came before the Court of Appeal, Lord Justice Stuart-Smith stated that the attempt to formulate a duty of care as pleaded,

> "is wholly misconceived. If a duty of care exists at all, it is a duty to prevent the plaintiff from suffering injury, loss or damage of the type in question, in this case psychiatric injury. A failure to attend to give evidence could be a breach of such duty, but it is not the duty itself."

Later, Lord Justice Stuart-Smith stated:

> "it is quite plain in my judgment that the defendant, in carrying out an examination at the behest of the police or Crown Prosecution Service, did not assume any responsibility for the plaintiff's psychiatric welfare; the doctor/patient relationship did not arise."

He concluded his judgment:

> "it is of no assistance to the plaintiff here in trying to construct a duty of care to attend court to give evidence which, as I have already pointed out, could amount to breach of a wider duty which is not alleged and could not be supported."

The other two Lords Justice of Appeal agreed. Lord Justice Clarke observed that:

> "In (the circumstances of the case) any duty of care owed (by the FME) must be very restricted. It seems to me that she must have owed a duty of care to carry out any examination with reasonable care, and thus, for example, not to make matters worse by causing injury to the plaintiff. It also seems to me to be at least arguable that where an FME carries out an examination and discovers that the person being examined has, say, a serious condition which needs immediate treatment, he or she owes a duty to that person to inform him or her of the position."

The claimant's action against the FME for damages was dismissed, and it was confirmed that there was no duty of care owed by the FME to the victim to attend the trial as a prosecution witness when required.

References

1. Airedale NHS Trust v Bland (1993) AC789, 857 per Lord Keith of Kinkel
2. Consent: patients and doctors making decisions together General Medical Council, London (2008)
3. St George's Healthcare NHS Trust v S (No 2): R v Louise Collins & Ors Ex parte S (No 2) (1998) (Guidelines issued by the Court of Appeal as to steps to be taken when patient refuses consent to necessary treatment)
4. In re C (1994) 1WLR 290
5. Sidaway v Board of Governors of the Bethlem Royal and Maudsley Hospitals (1985) AC 871; [1985] 1 AllER 643
6. Rogers v Whitaker (1992) 175 CLR 479; [1992] AMLD 6993; 16 BMLR, 148 (Australian High Court)
7. Canterbury v Spence (1972) 464 F2d 772 (US App DC)
8. Reibl v Hughes 114 DLR 3d 1 (Canadian Supreme Court 1980); (1980) 2 SCR 880
9. Bolitho v City & Hackney Health Authority (1998) AC 232; [1998] 1 Lloyd's Rep. Med. 26
10. Chester v Afshar (2004) UKHL 41
11. In re F (1990) 2.AC 1
12. Bolam v Friern Hospital Management Committee (1957) 2 AllER 118; [1957] 1 WLR 582
13. Gillick v West Norfolk & Wisbech Area Health Authority (1984) AC 112
14. Guidelines for doctors asked to perform intimate body searches, British Medical Association and Faculty of Forensic and Legal Medicine, London (2010)
15. General Medical Council. Making and using visual and audio recordings of patients. General Medical Council, London (2002)
16. British Medical Association. Taking and using video and audio images of patients. British Medical Association, London (2009)
17. Guidance for best practice for the management of intimate images that may become evidence in court, Faculty of Forensic and Legal Medicine and Royal College of Paediatrics and Child Health, London (2010)
18. Extract from the Hippocratic Oath. 5th century BC
19. Confidentiality, General Medical Council, London (2009)
20. Association of Police Surgeons and British Medical Association. Revised interim guidelines on confidentiality for police surgeons in England, Wales and Northern Ireland. Association of Police Surgeons (now the Association of Forensic Physicians), East Kilbride. British Medical Association, London (1998)
21. Tarasoff v Regents of the University of California (1976) P 551 2d 334 (Cal. Sup. Ct. 1976)
22. W v Egdell (1990) Ch. 359; [1990] 1 All ER 835
23. Confidentiality: reporting gunshot and knife wounds, General Medical Council, London (2009)
24. Good Medical Practice, General Medical Council, London (2006)
25. National Justice Compania Naviera SA v Prudential Assurance Co. Ltd. ("The Ikarian Reefer"); (The Times, March 5, 1993); (1993) 2 Lloyd's Rep. 68 (High Court 1993); [1995] 1 Lloyd's Rep. 455 (CA 1995)
26. Academy of Experts and Expert Witness Institute joint Code of Practice. Endorsed by Master of Rolls 22 June (2005)
27. General Medical Council Acting as an Expert Witness – guidance for doctors, UK (2009)
28. Whitehouse v Jordan (1981) 1WLR 246, 256 per Lord Wilberforce
29. Polivitte Ltd v Commercial Union Assurance Co. (1987) plc 1 Lloyd's Rep. 379, 386 per Garland J
30. Derby & Co. Ltd. and Others v Weldon and Others (No. 9) The Times, November 9, (1990) per Staughton LJ
31. Expert Witness Institute (2011). http://www.Ewi.org.uk. Accessed 20 June 2011
32. Civil Procedure Rules. The Stationery Office, London (1999); and on the Department of Constitutional Affairs (formerly Lord Chancellor's Department). Available at Website: http://www.dca.gov/uk
33. Re N (1999) Lloyds Law Reports (Medical) 257; [1999] EWCA Civ 1452

Chapter 3
Sexual Assault Examination

Deborah Rogers and B. Martina McBride*

Introduction

Sexual assaults create significant health and legislative problems for every society. All health professionals who have the potential to encounter victims of sexual assaults should have some understanding of the acute and chronic health problems that may ensue from an assault. However, the primary clinical forensic assessment of complainants and suspects of sexual assault should only be conducted by doctors and nurses who have acquired specialist knowledge, skills, and attitudes during theoretical and practical training.

There are many types of sexual assault, only some of which involve penetration of a body cavity. This chapter encourages the practitioner to undertake an evidence-based forensic medical examination based on the allegation, persistence data, and any available intelligence.

The chapter commences by addressing the basic principles of the medical examination for both complainants and suspects of sexual assault. Although the first concern of the forensic practitioner is always the medical care of the patient, thereafter the retrieval and preservation of forensic evidence is paramount because this material may be critical for the elimination of a suspect, identification of the assailant, and the prosecution of the case. Thus, it is imperative that all forensic practitioners understand the basic principles of the forensic analysis.

The text is then divided into sections covering the relevant body areas and fluids. Each body cavity section commences with information regarding the range and frequency of normal sexual practices and the relevant anatomy, development,

*In consultation with the Association of Forensic Science Providers Body Fluid Forum [1].

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and physiology. This specialist knowledge is mandatory for the reliable documentation and interpretation of any medical findings. The practical aspects – which samples to obtain, how to obtain them, and the clinical details required by the forensic scientist – are then addressed, because this takes priority over the clinical forensic assessment.

The medical findings in cases of sexual assault should always be addressed in the context of the injuries and other medical problems associated with consensual sexual practices. Therefore, each section summarizes the information that is available in the literature regarding the noninfectious medical complications of consensual sexual practices and possible nonsexual explanations for the findings. The type, site, and frequency of the injuries described in association with sexual assaults that relate to each body area are then discussed. Unfortunately, space does not allow for a critical appraisal of all the chronic medical findings purported to be associated with child sexual abuse, and the reader should refer to more substantive texts and review papers for this information [2–4].

Throughout all the stages of the clinical forensic assessment, the forensic practitioner must avoid partisanship while remaining sensitive to the immense psychological and physical trauma that a complainant may have incurred. Although presented at the end of the chapter, the continuing care of the complainant is essentially an ongoing process throughout and beyond the primary clinical forensic assessment.

Basic Principles of the Medical Examination

Immediate Care

The first health care professional to encounter the patient must give urgent attention to any immediate medical needs that are apparent, e.g., substance overdose, head injury, or serious wounds. This care takes precedence over any forensic concerns. Nonetheless, it may be possible to have a health care worker retain any clothing or sanitary wear that is removed from a complainant, until this can be handed to someone with specialist knowledge of forensic packaging. It is important to keep a record of who handles the clothing to maintain the "chain of evidence." It is acknowledged that in an emergency, clothing may have to be cut to facilitate its removal. However, if at all possible, any preexisting breaks in a garment, such as tears or stab holes, should be avoided.

Timing of the Examination

Although in general terms the clinical forensic assessment should occur as soon as possible, reference to the persistence data given under the relevant sections and the acute medical needs of the patient (see Section "Care of the Complainant") will help the forensic practitioner determine whether the examination of a complainant should be conducted during out-of-office hours or deferred until the next day. Even when the nature of the assault suggests there is unlikely to be any forensic evidence, the timing of the examination should be influenced by the speed with which clinical signs, such as reddening, will fade.

The timing of the examination of a suspect needs to be agreed with the detaining police personnel.

Place of the Examination

Specially designed facilities used exclusively for the examination of complainants of sexual offenses are available in many countries. Furnishings in these units should be plastic, leatherette, or any other washable type surface that is durable and suitable for cleaning between examinations [5]. The complainant may wish to have a friend or relative present for all or part of the examination, and this wish should be accommodated. The presence of this individual should be recorded in the event that a DNA elimination sample is needed from them at a later date. Suspects are usually examined in the medical room of the police station and may wish to have a legal representative present.

During the examinations of both complainants and suspects, the local ethical guidance regarding the conduct of intimate examinations should be followed [6].

Consent

Informed consent must be sought for each stage of the clinical forensic assessment, including the use of any specialist techniques or equipment (e.g., colposcope) and obtaining the relevant forensic samples. Local ethical guidance and recommendations regarding assessing capacity to consent and how to proceed if the patient lacks capacity should be followed [7]. When obtaining consent, the patient and/or parent should be advised that the practitioner is unable to guarantee confidentiality of the material gleaned during the medical examination because a judge, or other presiding court officer, can rule that the practitioner should breach medical confidentiality. They should be advised that toxicology screens are wide ranging and may detect illicit substances that have nothing to do with the sexual assault. If photo documentation is to form part of the medical examination, the patient should be advised in advance of the means of storage and its potential uses (see Section "Ownership and Handling of Photo Documentation"); specific written consent should then be sought for this procedure. The patient must be advised that he or she can stop the examination at any time.

Details of the Allegation

If the complainant has already provided the details of the allegation to another professional, e.g., a crisis worker or police officer, it is not necessary for him or her to repeat the details to the forensic practitioner. Indeed, Hicks [8] notes that attempts to obtain too detailed a history of the incident from the complainant may jeopardize the case at trial because at the time of the medical examination the patient may be disturbed and, consequently, the details of the incident may be confused and conflict with subsequent statements. The details of the allegation can be provided to the forensic practitioner by the third party and then clarified, if necessary, with the complainant. It may be difficult for the complainant to describe oral and anal penetrative sexual assaults, and the forensic practitioner may need to ask direct questions regarding these acts sensitively [9].

Forensic practitioners should not ask suspects about the alleged incident.

Medical and Sexual History

The purpose of obtaining the medical and sexual history is essentially twofold. First, to identify any behavior or medical conditions that may cause the doctor to misinterpret the clinical findings, e.g., self-inflicted injuries or menstrual bleeding, and second, to identify any medical problems that may be attributable to the sexual assault, e.g., bleeding, pain, or discharge. Other specific details may be required if emergency contraception is being considered.

When children are examined, the parent or caregiver should provide comprehensive details of the past medical history. When adult complainants are examined, only relevant medical and sexual history should be sought because confidentiality cannot be guaranteed. What constitutes relevant medical history must be determined on a case-by-case basis by considering the differential causes for any medical findings and the persistence data for the different sexual acts. In general, information regarding sexual activity up to 7–10 days before the offense could be relevant.

Forensic practitioners should not ask suspects about their sexual history.

Nature of the Examination

General Examination

In all cases, a complete general medical examination should be conducted to document injuries and to note any disease that may affect the interpretation of the medical findings.

Anogenital Examination

Whenever there is a clear account of the alleged incident, the anogenital examination should be tailored to the individual case (e.g., if an adult complainant only describes being made to perform fellatio, there is usually no indication to examine the external genitalia). However, in some cases, the complainant may not be aware of the nature of the sexual assault. Furthermore, children and some adults may not have the language skills or may feel unable to provide a detailed account of the sexual acts at the initial interview. In such cases, a comprehensive anogenital examination should be undertaken if the patient or the person with legal authority to consent on behalf of the patient gives his or her consent.

Ownership and Handling of Photo Documentation

Any video or photographic material should be retained as part of the practitioner's confidential medical notes and stored in a locked cabinet at locked premises. To preserve anonymity, the material should be labeled both on the casing and within the video/photograph itself (by holding a card within the frame) using either an identification code or the patient's initials and the date of the examination. With the specific consent of the patient, the DVD video/photograph can be shown to other colleagues for second opinions, viewed by a named doctor providing expert testimony for the defense, and used for teaching purposes. The material should not be released to nonmedical parties except on the directions of the court [10].

Basic Principles of the Forensic Analysis

In general, the scientific examination at the forensic laboratory can provide information regarding:

- What sexual acts have occurred
- The gender and possible identification of the assailant
- Potential links with any other offenses

In practice, the role of the forensic scientist in sexual assault cases varies with the case circumstances. Most sexual assaults fall into one of the following four categories:

1. Stranger sexual assaults where the identity of the assailant is unknown. Here the primary objective of the forensic scientist is to find any body fluid stain on samples from the complainant's body, clothes, or scene that would yield the DNA profile of the offender.
2. Cases where the accused alleges that the other party consented to the sexual act. These are the most common type of sexual assault. In these cases, the best way the forensic scientist can help progress the case is by looking for any discrepancy between the accounts of the complainant and the suspect that can be addressed

forensically. The scientist would also examine the clothing for damage beyond what would be expected from normal wear and tear.

3. Cases where the complainant has an unclear recollection. These are usually associated with alcohol or drug consumption. Sometimes the complainant alleges interference with their drink. The role of the scientist is usually to establish whether sexual activity took place. Toxicological analysis of the complainant's urine, blood, and sometimes hair samples may indicate drug or alcohol consumption.
4. In cases where sexual abuse of a child is alleged, the suspect usually denies that any sexual activity has taken place. The scientist's role is to look for evidence of the alleged sexual activity. The examination results often have to be interpreted carefully as the alleged offender often has legitimate access to the complainant, and there could be innocent explanations for some of the findings. Some of these cases can be historical or can involve multiple offenders.

Prevention of Contamination

To ensure that there is no accidental transfer of body fluids or fibers between the parties who have been involved in a sexual act, each complainant and each suspect should be transported in separate vehicles and examined in different locations by different forensic practitioners. If it is not possible to have different forensic practitioners, they should be advised to use appropriate personal protective equipment.

Because of the sensitivity of the techniques used to extract and analyze DNA, forensic practitioners should take all possible steps to ensure that their own cellular material does not contaminate the samples they obtain. Therefore, gloves must be worn throughout the forensic examination and changed when sampling different body areas. Some jurisdictions require that all used gloves should be retained and exhibited. Disposable plastic aprons and disposable sleeves are worn in some jurisdictions. In addition, the forensic practitioner should avoid talking, coughing, or sneezing over unsealed samples and should handle all samples as little as possible. If a forensic practitioner believes that there is a possibility that he or she will cough or sneeze over an unsheathed swab, a face mask should be worn when the sample is being obtained.

The examination couch should be cleaned with bleach or a recommended cleaning agent that destroys DNA, before and after the examination. A disposable couch cover should be used on the couch and fresh paper roll may be used as a "sheet."

Collection of Forensic Samples

The swabs and containers used to collect forensic evidence differ from those used in clinical tests. The swabs should be made of fibers that readily release absorbed material [11–13]. The quality and integrity of any swab or container used to obtain a forensic sample must be ensured. The provision of sealed, standardized clinical forensic examination kits or modules ensures that these requirements can be attained [14, 15].

Forensic swabs should be placed in plastic sheaths that do not contain transport media or in specially designed boxes that allow the swabs to air-dry. Blood and urine samples for drug and alcohol analysis should be placed in containers with a preservative that prevents decomposition and fermentation (e.g., sodium fluoride), and the container for the blood sample should also contain an anticoagulant (e.g., potassium oxalate). The blood sample for DNA analysis should be placed in a container with the appropriate preservative (e.g., ethylene diaminetetraacetic acid). All the containers should be shatterproof as many of the samples are subsequently frozen.

Only sealed, disposable instruments (e.g., proctoscopes, specula, scissors, and forceps) should be used to retrieve forensic samples. All instruments used in the sampling process should be retained. However, if storage space is restricted, then any used instruments may be swabbed and only the swabs retained for later forensic sampling.

Water-based lubricants from a single-use sachet (Pedicat® or KY® Lubricating Jelly) may be used to moisten the proctoscope/speculum to facilitate its insertion into a body orifice [16]. The empty sachet should be retained and packaged in a "tamper-evident bag" (see Section "Packaging and Continuity"). Sterile water may be used as a substitute to lubricants.

Controls

An unopened swab from each batch should be retained and sent with the samples as a control for that batch of swabs.

Packaging and Continuity

Any retrieved items must be packaged quickly and efficiently to prevent accidental loss of material and minimize decomposition of the sample. The use of bags with integral tamper-evident seals is recommended to prove that the sample has not been contaminated with exogenous substances since it was sealed.

It is the responsibility of the person who obtains the sample to ensure it is appropriately labeled. A crisis worker, police officer, or scene of crime officer may assist with the labeling process, but the forensic practitioner must check the labels before signing. The swabs and bags vary between jurisdictions and many do not have appropriate headings on the labels.

The information on each exhibit and tamper-evident bag should comply with local recommendations. The information below gives the recommendations for England and Wales [17].

Swabs, Sheaths, and Bottles

These should be labeled with the following information:

- Name of person (or reference number for self-referrals) from whom the sample was taken (examinee)
- Description of the sample, e.g., high vaginal swab A
- Item/exhibit number using the forensic practitioner's initials, e.g., DJR/10
- Date on which the sample was taken
- Blood and urine only – time at which the sample was taken (24 h clock)

Where two swabs have been taken from the same site, it is *imperative* that there is a clear indication on the label regarding the order in which the swabs were obtained. This is most easily done by describing the first of the two samples as sample A and the second as sample B.

Tamper-Evident Exhibit Bags

The use of bags with integral labels will prevent accidental detachment of this vital information (see Fig. 3.1).

The exhibit bags should be labeled with the following information:

- Name of person (or reference number for self-referrals) from whom the sample was taken (examinee)
- Description of the samples, e.g., high vaginal swabs
- Item/exhibit number using the forensic practitioner's initials, e.g., DJR/10
- Date on which the sample was taken
- Blood and urine only – time at which the sample was taken (24 h clock)
- The signature of the person who first handled the exhibit, and thereafter
- The signatures of all other persons who handled the exhibit

The clothing worn by the complainant during or after the incident may be an invaluable source of information in terms of the nature of the assault (e.g., damage to clothing and body fluid stains) and the identification of the assailant. Even stains on clothing that has been washed have been found to contain sufficient spermatozoa to produce a DNA profile [18, 19]. Clothing should be placed in bags made of material, such as paper, that prevents the accumulation of condensation, which could accelerate decomposition of body fluids. Submitted clothing should be sealed and labeled as described previously. When the clothing is overtly wet or possibly contaminated with accelerants, the forensic science laboratory should be asked for advice on packaging and storage. The following additional information should then be recorded on the appropriate label:

Which items were worn during the offense
Which items were removed and not replaced
Which items were removed and replaced
Which new items were worn after the offense
Which, if any, items were washed since the offense

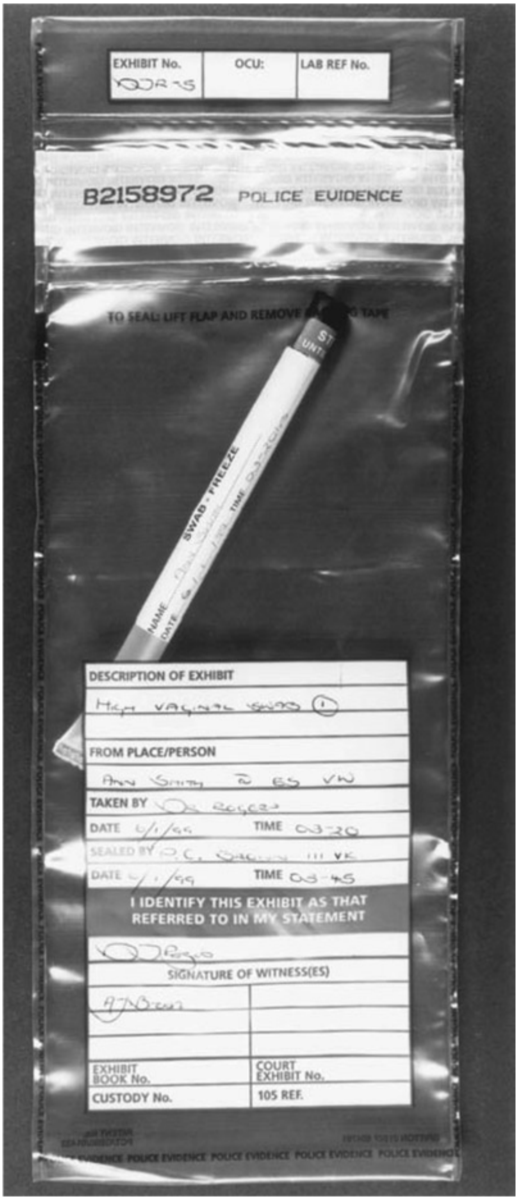

Fig. 3.1 Exhibit bag with integral label and tamper-evident seal

The forensic scientist must be provided with salient information regarding the incident and subsequent actions of the complainant to determine the type of forensic analysis required. A useful means of transmitting this information is via a pro forma (see Fig. 3.2).

Faculty of Forensic and Legal Medicine

Pro Forma

Forensic Medical Examination Form 1

INFORMATION FORM use for examination of **COMPLAINANT ONLY.**
All sections of this form must be completed and a copy submitted with the samples.
Please **PRINT IN CAPITALS** using a ball-point pen and tick the appropriate boxes.

GENERAL INFORMATION

Name of Complainant: Case Reference Number:

Address of Examination Facility: Age: Sex: M F

Weight: Height:

Date & Time of Incident: Date & Time of Examination:
(please use 24hr clock)

Date(s) & Time(s) of other relevant sexual activity within the previous 10 days

Items used in previous intercourse: Condom ☐ Spermicide ☐ Lubricant ☐ Other *(specify)* ☐

SPECIFIC INFORMATION RELATING TO THE ALLEGED OFFENCE

					Details
Kissing / licking / biting / sucking / spitting?	N/K ☐	No ☐	Yes ☐		
Mouth to genitalia / anus?	N/K ☐	No ☐	Yes ☐		
Digit to vulva / vagina / anus?	N/K ☐	No ☐	Yes ☐		
Penis into vulva / vagina?	N/K ☐	No ☐	Yes ☐		
Penis into mouth?	N/K ☐	No ☐	Yes ☐		
Penis into anus?	N/K ☐	No ☐	Yes ☐		
Ejaculation?	N/K ☐	No ☐	Yes ☐		
Object to vulva / vagina / anus?	N/K ☐	No ☐	Yes ☐		
Other sexual / physical act(s)	N/K ☐	No ☐	Yes ☐		
Injuries?	N/K ☐	No ☐	Yes ☐		
Ano-genital bleeding?	N/K ☐	No ☐	Yes ☐		
Weapon used?	N/K ☐	No ☐	Yes ☐		
Condom / lubricant / spermicide used	N/K ☐	No ☐	Yes ☐		
Menstrual bleeding	N/K ☐	No ☐	Yes ☐		
The following removed / inserted	N/K ☐	Pad ☐	Tampon ☐	Sponge ☐	Diaphragm ☐
Showered / washed / bathed / douched	N/K ☐	No ☐	Yes ☐		
Genital /anal / relevant skin area wiped	N/K ☐	No ☐	Yes ☐		
Anal intercourse: defaecated since offence	N/K ☐	No ☐	Yes ☐		
Oral intercourse: mouth cleansed or eaten or drank since offence	N/K ☐ Drink ☐	No ☐ Mouthwash ☐	Yes ☐ Toothbrush ☐	Eaten ☐	

TOXICOLOGY INFORMATION

Was alcohol consumed? N/K ☐ No ☐ Yes ☐

If yes, please specify: Prior ☐ During ☐ After ☐ offence

Start time of drinking: End time of drinking:

Quantity and type of alcoholic beverage consumed:

If known, please specify the time of previous urination (i.e. time of urination prior to the specimen provided in this examination)

Date: Time:

Have any drugs (prescribed or otherwise) been used by/administered to the subject within 4 days of the examination?

N/K ☐ No ☐ Yes ☐ If yes, please specify: Prior ☐ During ☐ After ☐ offence

Give details:

Are other substances suspected of having been used/administered, which could be relevant to the offence?

N/K ☐ No ☐ Yes ☐ If yes, please specify: Prior ☐ During ☐ After ☐ offence

Give details:

Print name of person undertaking medical examination Contact telephone number:

Signature of person undertaking medical examination Date:

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Review date June 2010 info@fflm.ac.uk

Sheet 1 of 4

Fig. 3.2 Pro forma to relay relevant information to forensic scientist (reproduced with permission of the members of the Forensic Science Subcommittee of the Faculty of Forensic and Legal Medicine)

Analysis

Identification microscopy (e.g., spermatozoa) and immunodiagnostic techniques are used in the identification of body fluids. Microscopy is also used for hairs and fibers.

Discovery of the specificity of an individual's DNA profile has considerably enhanced the information that can be provided by a forensic science service (FSS) for connecting a person to an offense and linking offenses to each other. Although a detailed consideration of current DNA techniques is beyond the scope of this chapter, a general understanding of the terms and techniques will benefit the forensic practitioner.

Except for identical twins, each person's nuclear DNA is unique. An individual's gender and DNA profile may be obtained from any of his or her body fluids or tissues (e.g., blood, semen, and bones). The current technical process used for DNA profiling is termed short tandem repeat (STR) analysis. STR loci are a class of polymorphic markers consisting of simple repeated sequences of 1–6 base pairs in length. STRs are present throughout the human genome (DNA), occurring, on average, every 6–10 kb along the DNA and may exhibit a high degree of length variation resulting from differences in the number of repeat units displayed by individuals. Their abundance and hypervariability make them ideal markers for the identification of an individual. When a DNA STR analysis is performed, the specific areas of interest on the molecule are initially targeted. Multiple copies of these areas are then produced using polymerase chain reaction (PCR) techniques, which amplify minute amounts of DNA. The DNA pieces are then sorted according to their size, producing the individual's DNA STR profile [20].

DNA STR analysis, including a DNA sex test [21], is now part of the routine forensic assessment of biological samples in Europe and has largely replaced both traditional serological analysis of blood groups and classical single- and multilocus DNA fingerprinting [20]. The formation of the European DNA Profiling Group has led to the standardization of DNA analysis procedures used in the European community and associated western European countries. The current standard system focuses on the analysis of ten STR loci and is known as AMPflSTR® SGMPlus™. This system contains all of the Interpol and European Networks Forensic Science International (ENFSI) recommended European loci, which provides points of comparison for DNA intelligence purposes outside of the UK [22–29]. In 2010, it is hoped to upgrade the current SGMPlus system to Next Generation Multiplex (NGM). This will increase the number of loci analyzed from 10 to 15 to provide even more discriminating power.

When DNA profiling was first applied to forensic science, large amounts of nucleated material were required. However, the use of PCR technology has enabled much smaller amounts of material to be analyzed. Furthermore, when there are only small amounts of DNA, a technique termed low template (LT) DNA profiling may be used to obtain an STR profile. LT is a highly sensitive extension of the AMPflSTR® SGMPlus™ that has led to an increase in the sample types suitable for DNA testing, which, in turn, can provide valuable intelligence to the police. Because DNA is physically much more resistant to degradation than proteins, it is even possible to analyze degraded samples [30].

Y-Short tandem repeats (YSTRs) markers is another technique used in cases where there is a large amount of female DNA, which would swamp any male cells present. Over 200 STR markers have been identified on the Y chromosome. Commercial kits are currently available for at least six of these [31]. These are useful in cases of sexual assault where the male has been vasectomized. In these cases, the absence of sperm would mean that only a small amount of DNA would be present on intimate swabs after ejaculation and the female's DNA would swamp these. By specifically targeting the Y chromosome STR markers, it is possible to locate and amplify the small amount of male DNA present.

Fluorescence in situ hybridization (FISH) is a new technology that uses a fluorescein-tagged Y-specific DNA probe to label male epithelial cells. Once identified, the cells may be separated from the rest of the sample and submitted for DNA profiling. Without separation, the profile may be dominated by female DNA from the examinee, making it difficult to interpret (see Sections "DNA Analysis" and "Seminal Fluid").

Mitochondrial DNA analysis has been used in forensic casework. This technique examines the DNA contained within mitochondria and obviates the need for nuclear material [32]. As there are numerous mitochondria in a single cell and each contains multiple copies of the mitochondrial genome, it is possible to extract far more mitochondrial DNA than nuclear DNA. This is useful when cells have become degraded through decomposition or burning. The technique is also suited to discrete samples, such as hairs without roots and fecal material, but is not ideal for mixtures of body fluids, particularly when the complainant's body fluid is likely to be present in larger quantities than that of the assailant (Tully G, personal communication, 1998). Mitochondrial DNA is only passed from mother to child (unlike nuclear DNA, there is no contribution from the father); therefore, all the descendants along the maternal line will have the same mitochondrial DNA. It also has a much lower discrimination power that nuclear DNA profiling. Therefore, in sexual offenses, the selection of material to be analyzed by this technique is limited and its use needs careful consideration.

The forensic science laboratory must be notified when it is alleged that people who are closely related have been involved in a sexual offense, because their profiles will have greater similarity than profiles from individuals picked at random, and further differentiating tests may need to be performed.

Increasingly in the past few years, messenger RNA (mRNA) profiling has been proposed as a new method of body fluid identification and a lot of research is being carried out in this area. Techniques to use mRNA profiling to distinguish between menstrual blood and traumatic bleeding and buccal epithelial cells from other epithelial cells are being investigated [33, 34].

Skin

The comments in this section refer to nongenital skin. For genital and perianal skin, see Sections "Female Genitalia", "Male Genitalia, and "Perianal Area and Anal Canal."

Forensic Evidence

All areas of unwashed skin that have been licked, kissed, sucked, bitten, or ejaculated on by either the assailant or the complainant must be sampled. Cellular material, amenable to DNA profiling techniques, has also been identified where there has been skin-to-skin contact (e.g., manual strangulation or gripping the arm) [35, 36].

When dealing with an assault conducted by an unknown assailant, consideration should be given to sampling marks or injuries on the skin that the complainant attributes to direct contact by the offender. If the subject has not bathed or showered, then the relevant area of skin may be sampled up to 7 days after the incident (see "Skin" Section "Persistence Data").

Trace DNA and Secondary Transfer

Trace DNA is a term used to describe the minute quantities of DNA transferred generally through skin contact. The small number and nature of these transferred DNA-bearing cells make identification of the cellular source of origin (buccal, epithelial, etc.) either impractical or impossible [37].

Secondary transfer occurs when DNA deposited on a surface transfers to a second surface. When there is no dispute about the parties being together socially, the forensic biologist has to consider the possibility of secondary transfer as an alternative explanation for the presence of the DNA.

Preliminary work carried out by the Body Fluid Forum of the UK and Ireland [1] indicates that female DNA may sometimes transfer to the man's underpants following nonintimate social contact. In one experiment, vigorous contact took place between both parties' hands and between the male's hands and female's face; the male went to the toilet and simulated urination. Subsequent analysis showed that in a small number of cases female DNA was transferred to the male's underpants (Jones S, personal communication, 2010).

Lowe et al. [38] conducted experiments which showed that caution should be exercised in interpretation of results where trace DNA is involved. Her experiment involved two people, one a good DNA shedder and another a poor shedder holding hands for 1 min after which the poor shedder immediately held a plastic tube. In one case, she detected only the good shedder on the tube even though it was the poor shedder who touched the tube. No evidence of a mixed profile was observed. Therefore, the vector was not always the one with the most dominant profile on an object. Since these experiments there have been numerous examples of DNA transferred from a good shedder via a poor shedder onto an object [39, 40].

Method of Sampling

Although several techniques, including the use of surgical gauze pads [41] and cigarette papers [42], have been used to recover saliva and other trace evidence from the skin with variable success, the use of sterile swabs is the most widely used technique that has received international endorsement [43]. If the skin appears moist, the stain should be retrieved on dry swabs, which are then placed in sheaths without transport medium. The double-swab technique, described by Sweet et al., is the recommended method to recover dried stains or possible cellular material from skin [44]. When using this technique, sterile water is used to wet completely the cotton tip of the first swab. The tip of the swab is then rolled over the area of skin using circular motions while rotating the swab on its long axis to ensure maximum contact between the skin and the swab. Then, a second dry swab is rolled over the same area to absorb the water left on the skin by the initial swab and collect any remaining cells. Minimal pressure should be applied to prevent exfoliation of the patient's own epithelial cells. The forensic practitioner should use as many swabs as necessary to remove any visible stain (repeating wet swab followed by dry swab). If no stain is visible, two swabs will suffice (the first wet; the second dry). The swabs are then placed in sheaths without transport medium.

Minitape lifting of possible cellular material is also now being used in some laboratories, and there are reports that it is more effective than swabbing for the recovery of salivary DNA [45]. Minitapes are small pieces of sterile adhesive tape on a plastic backing which can be pressed repeatedly onto the surface of skin to collect any loosely adhering cellular material [46]. Where skin swabs/lifts are taken, a control swab/lift should also be taken from an area adjacent to the staining. This is so the scientist can access the level of background DNA to aid interpretation when the presence of a body fluid/DNA in a specific area is significant.

Lighting

Some authors comment that ultraviolet (UV) light causes fluorescence of semen and saliva and advocate its use in determining the areas of skin to be swabbed [47, 48]. This advice must be interpreted cautiously, because a study by Santucci and colleagues found that although many creams and ointments fluoresced when exposed to a Wood's lamp (wavelength 360 nm), none of the 28 semen samples examined did [49]. In addition, other authors have commented that detergents, lubricants (particularly those that contain petroleum jelly), and milk fluoresce [50].

However, when semen stains are exposed to a high-intensity light source of variable wavelengths (e.g., the Polilight®) and viewed using goggles to block the strong excitation light, then semen may be detectable, even when the background surface is fluorescent [51]. Furthermore, the location of the stain may be recorded using photography.

Nelson and Santucci have described training forensic physicians to use an alternative light source (the Bluemaxx BM500) to identify semen (100% sensitivity) and to differentiate it from other products [52].

A recent survey of several forensic science laboratories in the UK and Ireland [1] found that most felt that using alternative light sources to detect stains on clothing and inanimate materials was of limited value because of the number of false positives and false negatives. However, the use of a Blue Crime – Lite (450 nm) may speed up detection time when used as a screening tool for the identification of seminal staining on large objects. If the search proves negative, further testing should be carried out for confirmation [53].

Forensic Analysis

The most common reason for the forensic analysis of skin swabs is the DNA testing of saliva deposited after licking, kissing, or biting of the skin. Forensic analysis for other body fluids or exogenous substances is considered elsewhere in the chapter.

Detection of Saliva

The only means of identifying the presence of saliva on the skin is by detecting the enzyme amylase. The traditional test available for this is the Phadebas® amylase test. However, amylase can be present in body fluids other than saliva, so in some instances this test is not suitable (see "Cunnilingus and Anilingus" Section "Forensic Analysis and Persistence Data"). New, more sensitive, tests including the RSID saliva kit detect human salivary α amylase at lower concentrations [54].

Identification of the Assailant

The preferred method for the forensic assessment of a possible saliva sample is the use of DNA STR or LT analysis.

Persistence Data

There is only limited information available regarding the persistence of body fluids and cellular material on the skin of the living. Rutty [35] studied the transference and survivability of human DNA after simulated manual strangulation. Although this study found that when using the LCN technique DNA was recoverable from either the victim's neck or the offender's fingers for at least 10 days after the contact, the author stressed that this apparent persistence may have resulted from secondary or tertiary transfer from other individuals or objects (the study subjects worked in the same building and shared the same bathroom and kitchen facilities during the period of the study) [35]. Sweet and colleagues have shown that it is possible to obtain a DNA profile from saliva stains (corresponding to a bite mark) on cadaver skin when the saliva was deposited up to 48 h earlier [55]. In a more recent publication [36], five volunteers had their partners deposit saliva on their neck. The following day, DNA profiles from the partners were obtained from the neck swabs of three of the five volunteers.

Kenna et al. [45] showed that DNA from saliva could yield a full profile up to 96 h after deposition on skin in eight of nine experiments carried out. In the Sweet study, the amount of recoverable material diminished with time; hence, it is prudent to sample the relevant body areas as soon as possible after the offense.

Medical Evidence

On average, 40% of complainants of sexual assaults will have no general injuries [56–60]. Of those who are injured, most will have only minor injuries, which will fade rapidly or heal without a trace [56, 57]. Nonetheless, the whole body must be thoroughly inspected for stains (e.g., dirt and blood), injuries (including signs of substance use), skin disease, and scars (including self-inflicted injuries). All injuries must be described using the recognized nomenclature described in Chap. 4 and recorded in terms of site (measured, if possible, from a fixed bony point), two-dimensional size, covering surface (e.g., scabbing, bleeding, or swelling), and color. The body surfaces should then be palpated and a note made of the site and approximate size of any tender areas. More credence will be given to a finding of tenderness if it is verified later in the consultation (ideally while the patient is distracted) or at a follow-up assessment, particularly if a bruise becomes apparent. All negative observations should also be recorded.

If the person can identify an injury that he or she believes was caused by a true bite, as opposed to a suction or "love-bite," or if the examination reveals an injury that has features that are suggestive of a bite, arrangements must be made for the area to be professionally photographed so that the injury can be considered by a forensic odontologist. Several studies have reported that the female breasts are bitten in 7–19% of sexual offenses [61, 62].

Preprinted body diagrams are useful for recording injuries. Although the original diagram is part of the forensic practitioner's contemporaneous record, where injuries are noted it would be extremely beneficial for copies to be appended to the statement or to the forms sent to the forensic scientist. The latter may use the diagrams to direct the forensic assessment (e.g., if the patient was bitten, the scientist will refer to the diagram to determine where to commence the search for saliva on any clothing that may have been contaminated concurrently). If saliva is present, it could yield a DNA profile. This can be particularly useful when there is a long time interval between the sexual assault and the medical examination or when the complainant has washed in the intervening time.

Hair: Head and Pubic

Forensic Evidence

Hair is most commonly sampled to detect body fluids or retrieve foreign hairs or particles. It has been known for many decades that numerous ingested prescribed and illicit drugs (e.g., barbiturates, amphetamines, opiates, cocaine, benzodiazepines, γ-hydroxy butyrate, and cannabis) are deposited in the hair [63]. Although toxicology of hair was originally used to detect drugs that had been repeatedly ingested, recent advances in analytical techniques have meant that toxicology may be useful after single-dose ingestion as would occur in a substance-facilitated sexual assault [64, 65]. This is particularly pertinent because complainants of possible drug-facilitated sexual assaults frequently do not report the incident expeditiously because of amnesia and/or doubt about what might have happened, and drugs may be accessible to analysis for longer periods in hair compared to blood or urine [66]. In addition, plucked hair may be used as a reference sample for DNA analysis.

Method of Sampling

Cutting

Hairs should be sampled by cutting if they appear to be contaminated by material that has the potential to have forensic significance (e.g., semen). If the patient does not consent to having the contaminated hairs cut or if it is not practical to cut them because of the extent of foreign material contamination, then the relevant areas can be swabbed (follow guidance in "Skin" Section "Method of Sampling").

For drug analysis, a pencil thickness of hairs should be cut close to the scalp [67]. In instances of single doses, it must be remembered that it takes approximately 4 weeks to emerge sufficiently above the scalp to be evident in cut hair. The ideal site for sampling is the posterior vertex (back of the crown of the head), although this may not be acceptable to the complainant. The hairs must be kept in line. To do this, it is recommended that the lock is tied together with a piece of cotton or string and the hair is then cut as close to the scalp as possible, the sampled hairs are then placed in aluminum foil. The foil should be marked at one end to show the cut end, then wrapped and placed in a sealed tamper-evident bag.

Combing/Low Adhesive Tape

Any foreign particles or foreign hairs identified on the head or pubic hair should be collected with forceps and submitted for analysis [68, 69]. If a balaclava or other article was worn on the head during the assault, the hair should be combed or sampled with low-tack adhesive tape, which is then attached to acetate [70]. Control samples of hair should be taken by cutting a representative sample as close to the scalp as possible (25 hairs if the hair appears uniform) and also "combing" the hair, either with an actual comb or with gloved fingers, to obtain a proportion of control head hairs with roots on them.

Pubic hairs may be transferred between individuals during sexual intercourse. Exline et al. [71] studied volunteer heterosexual couples who combed their pubic hairs immediately after sexual intercourse in the "missionary" position. Even under such optimal collection conditions, pubic hair transfers were only observed 17.3% of the time using macroscopic and microscopic comparisons. Pubic hair transfer to males (23.6%) was more common than transfer to females (10.9%).

Some studies on sexual offense case material have shown lower rates of pubic hair transfer between complainant and assailant. Mann [72] reported that only 4%

of female complainants and no male complainants were identified as having pubic hairs consistent with the assailant hairs isolated from combings of the pubic hair, and Stone [73] identified foreign pubic hairs among the pubic hair combings of 2% of the complainants studied. However, a survey of sexual offense case material submitted to laboratories throughout the USA [74] found pubic hairs that associated the complainant and the assailant in 15% of cases. Therefore, the authors advocate that, where relevant, the complainant's/suspect's pubic hairs should be combed onto a piece of uncontaminated paper (A4 size), with the patient in the semilithotomy position; the paper enclosing the comb should be folded inward and submitted for analysis. This will collect loose hairs and sufficient of the patient's hairs with roots to allow for microscopic interpretation. Other loose pubic hairs on the complainant that are macroscopically different from his or her own pubic hairs can be collected with sterile forceps and submitted for forensic analysis.

Reference Sample for DNA Analysis

If it is not possible to obtain buccal cells or a blood sample, then one can seek the examinee's consent to obtain 10–25 head hairs with attached roots (plucked individually while wearing gloves) for use as the reference sample.

Forensic Analysis

Chemical Analysis

Chemical analysis may be relevant if the hair has been dyed or contaminated with exogenous substances, such as a lubricant or hairspray.

Microscopy

Microscopic hair comparisons are no longer routinely carried out in most laboratories. If a hair needs to be attributed to a particular source, it can be examined macroscopically, and if it is visually similar to the control sample, it can be DNA profiled. Microscopic examination of hair roots may indicate whether they were pulled or shed naturally.

DNA Analysis

DNA analysis of hair is most successful when the root is present as some cells may have come away with the root.

However, with the improved sensitivity provided by PCR techniques and the development of mitochondrial DNA analysis, stronger, more objective conclusions in terms of assailant identification can be reached from hairs without roots [75].

Research has recently been undertaken to determine whether FISH technology could be used to identify the gender of retrieved hair. The research has demonstrated that there is a potential forensic application in this area [76].

Drug Analysis

Only specialist laboratories offer hair analysis because hair specimens are not suitable for comprehensive drug screens, and the sample is quickly consumed in testing for a few drugs [77–79]. It must be noted that hair cannot be tested for alcohol.

Persistence Data

There are no data on how long after the assault foreign pubic hairs have been retrieved from a complainant. Although spermatozoa have been recovered from head hair that was washed [80], there is no detailed data regarding the persistence of spermatozoa on the hair

Hair grows at a rate of 0.7–1.5 cm/30 days [67]. Therefore, cutting the hair will eventually remove the section of hair where the drugs have been deposited.

Medical Evidence

Occasionally, head or pubic hairs may have been accidentally or deliberately pulled out during a sexual assault; the identification of bleeding hair follicles would support this complaint. It may be alleged that hairs have been cut by a knife or a scissors during an assault. It is possible for the hairs to be examined microscopically to determine whether they have been cut.

Nails

Forensic Evidence

During the course of a sexual assault, trace materials, such as skin, body fluids, hairs, fibers, and soil, can collect under the fingernails of both the complainant and the assailant. The latter deserve particular attention because digital vaginal penetration is alleged to have occurred in nearly one in five (18%) of the sexual assault cases submitted for analysis to the FSS; frequently, this is a precursor to another penetrative act (Newton M, personal communication, 2003). A study undertaken by Neville in a forensic laboratory found that 38% of individuals have DNA from someone other than themselves under their fingernails (Neville S, personal communication, 2002), and recent studies have found that when foreign DNA is found under fingernails, it is likely to be from a partner [81–83]. Therefore, it is important to remember that foreign DNA found under the fingernails can have an innocent explanation, and care must be exercised when considering this type of testing if the victim and suspect have legitimate access to each other. Fingernail samples should be obtained from the complainant if the circumstances of the offense suggest that trace material may be present and relevant; e.g., in a stranger rape or if the details of the assault are uncertain and the forensic practitioner, in observing the complainant's hands, notices material of interest under or on the surface of the nails. They should also be considered if a fingernail broke during the offense and the broken section may be recovered from the scene. Samples should be obtained from the suspect if it is alleged that his or her hands had direct contact with the female genitalia or if he or she scratched the complainant.

Method of Sampling

The optimal sample is clippings of the whole fingernail as these are more practical to handle. This also allows the scientist to examine the clippings before DNA profiling and selectively target any skin or bloodstains present. This minimizes the amount of background DNA from the complainant being profiled. The fingernails should be swabbed after clipping. Swabbing of the material under the nails should be carried out using small pointed swabs and the double-swab technique (see "Skin" Section "Method of Sampling"). One wet and one dry swab should be taken for each hand. If a particular finger is significant, it should be swabbed separately. Specimens should be packaged separately in sealed tamper-evident bags. When obtaining fingernail swabbings, the forensic practitioner should try not to disturb the nail bed.

However, in some cases, the fingernails may be too short to clip or the complainant may withhold consent for the sample; complainants who cherish their well-manicured nails may find the proposal distressing, and the examiner must be sensitive to this. In such cases, the nails should be swabbed as above. On the rare occasions when a nail has broken during the incident and the broken fragment of nail is recovered, the residual nail on the relevant finger should be clipped within 24 h to enable comparison of nail striations [84]. If it is not clear which finger the broken nail came from, then it may be necessary to clip and submit all the macroscopically broken nails, as the fingernail striations are individual to a particular finger.

Forensic Analysis

The fingernail samples may be examined microscopically for any visible staining. The nails would then be swabbed to remove any possible body fluids and the material submitted for DNA analysis. If the nails were swabbed rather than clipped, the swabs can be submitted directly for DNA analysis.

Persistence

Lederer reported recovery of DNA matching the complainant from a suspect's fingernails 2 days after the alleged digital penetration occurred; the suspect denied any form of contact and claimed to have washed his hands several times during the elapsed period [85].

Medical Examination

The length and any damage to fingernails should be noted.

Oral Cavity

Although the oral cavity may be injured in several ways during a sexual assault, the specific sexual acts that may result in forensic or medical evidence are fellatio, cunnilingus, and anilingus.

Fellatio

Definition

Fellatio (also referred to as irrumation) is a sexual activity in which the penis is placed in the mouth; sexual stimulation is achieved by sucking on the penis while it moves in and out of the oral cavity. Ejaculation may or may not occur.

Frequency

Consensual

Fellatio is part of the sexual repertoire of heterosexual and male homosexual couples. A study of 1,025 women attending a genitourinary clinic found that 55% practiced fellatio occasionally and 15% practiced fellatio often [86].

Nonconsensual

Fellatio is not an infrequent component of a sexual assault sometimes occurring in isolation but occurring more frequently in conjunction with other sexual acts [9].

Among the 1,507 (1,403 females, 104 males) sexual assault cases submitted to the Metropolitan Police Laboratory, London, during 1988 and 1989, 17% of the females and 14% of the males described performing fellatio and 31% of the males had fellatio performed on them during the sexual assault [87].

Legal Implications

The legal definitions of many jurisdictions, including England, Wales, and the Irish Republic, consider nonconsensual fellatio to be analogous to nonconsensual penile penetration of the vagina and anus [88, 89].

Forensic Evidence

Method of Sampling

After oral–penile contact, the oral cavity should be sampled when fellatio was performed during the sexual assault or in circumstances in which the details of the incident are unknown. There is no current worldwide consensus as to which is the best sampling method.

Possible techniques include saliva collection (ideally 10 mL), application of swabs, gauze pads [90], or filter paper [91], and oral rinses using 10 mL of distilled water (Newman J, personal communication, 1998). Willott and Crosse [92] reported that spermatozoa are found more often in the saliva sample compared with mouth swabs, but also highlight several cases in which spermatozoa were recovered from swabs taken from specific areas of the oral cavity (e.g., under the tongue, the roof of the mouth, and the lips).

Although no studies have investigated the order in which the samples should be taken, the current recommended practice, in England and Wales, is to take oral swabs first and then take a mouth rinse. Two swabs in sequence are rubbed over the inner and outer gum margins (with particular attention to the margins around the teeth); over the hard and, where tolerated, soft palate; on the inside of the cheeks and lips; and over both surfaces of the tongue. The mouth is then rinsed with 10 mL of sterile water, which is retained in a bottle as the final sample. The mouth rinse can be obtained by a police officer or other attending professional before the arrival of the forensic practitioner, minimizing any delay. Mouth rinses must be frozen as soon as possible as they tend to deteriorate over a few days.

Spermatozoa have also been recovered from dentures and other fixtures that have remained in situ during fellatio. Although the optimum exhibit for the forensic scientist would be the dental fixture itself understandably this may not be acceptable to the complainant. A compromise would be to swab the dental fixture. Interestingly, sufficient spermatozoa for a DNA profile have also been recovered using standard extraction techniques from chewing gum that was retained in the mouth during nonconsensual fellatio [90]. In this case, the gauze pad obtained at the scene of the incident and the oral swabs obtained subsequently during the medical were negative.

DNA reference sample: Buccal cells are the preferred DNA reference sample from both suspect and complainant. The buccal cells are obtained by firmly rubbing a special swab over the inside of the cheek. However, if there is an allegation of oral sex, buccal swabs should not be used as a reference sample unless taken at least 48 h after the incident [93].

Forensic Analysis

After actual or possible oral ejaculation, the sample is initially examined microscopically to identify spermatozoa (see Section "Spermatozoa") followed by DNA analysis if necessary.

Persistence Data

Rapid retrieval of the forensic samples from the oral cavity is of paramount importance because of the limited period that spermatozoa remain in this orifice. Even though the maximum persistence of spermatozoa in the oral cavity is recorded as 28–31 h, only a few spermatozoa are detected unless the sample is taken within a few hours of ejaculation [94]. Consequently, the forensic exhibits must be collected as soon as an allegation of nonconsensual fellatio is made, and law enforcement agencies should be instructed accordingly. In the UK and the Republic of Ireland, an early evidence kit is available for use by the first response police officer; this is particularly beneficial in cases where there may be a time delay before a medical examination can occur.

Although rinsing of the mouth, drinking, and brushing of teeth do not necessarily remove all traces of spermatozoa [95], such activities should be discouraged until the samples have been obtained. Spermatozoa have also been recovered from toothbrushes used by complainants to cleanse the mouth after fellatio (forensic scientists, personal communication, 1998).

In acts of fellatio, it is common for the semen to be spat or vomited onto clothing where it will remain until washed. Therefore, any potentially contaminated clothing or scene samples should be submitted for forensic examination.

Medical Evidence

Several case reports have documented palatal lesions after fellatio. Areas of petechial hemorrhage and confluent bruising have been described on the soft palate and at the junction between the hard and soft palates after consensual fellatio [96–98]. These areas of bruising vary from discrete single or bilateral lesions of 1.0–1.5 cm in diameter, located on or either side of the midline [97], to larger bands of bruising that cross the midline [96, 98]. The bruises are painless and resolve in 7–10 days [96, 97], although they may reappear with repeated fellatio [97].

A forensic practitioner may be asked to explain to the court why these bruises occur. Although the precise mechanism is unknown, the following hypotheses have been proffered:

Repeated contraction of the palatal muscles: As the penis touches the palatal mucosa, the gag reflex is activated, with resultant contraction of the soft palate and other constrictor muscles of the pharynx. It is suggested that the combination of retching and repeated palatal movements causes rupture of the blood vessels in the highly vascular palatal mucosa [96].

Sucking: Sucking on the penis produces a negative intraoral pressure, which is postulated to cause rupture of the blood vessels in the palatal mucosa. This theory is supported by the anecdotal accounts of oral surgeons who found petechial hemorrhages on the palates of children who "made a habit of forceful sucking into a drinking glass" [97].

Blunt trauma: Case reports describe palatal bruises subsequent to sexual assaults wherein a digit or digits have been forced into the mouth [99]. However, there is no specific evidence to support the hypothesis that direct blunt trauma from a penis can cause palatal bruising.

Erythema and an erosion of the hard palate have also been described after fellatio [97, 98], but the reliability of such findings is questionable. Indeed, in one such case, the mucositis was eventually diagnosed as oral candidiasis contracted from direct contact with an infected penis [98].

Other nonsexual causes for similar palatal lesions include infectious mononucleosis; local trauma (e.g., hard food stuffs or ill-fitting dentures); paroxysms of vomiting, coughing, or sneezing; playing a wind instrument; tumors; and bleeding diatheses [100]. Therefore, whenever palatal bruising, erythema, or erosions are identified during the examination of a complainant who may have been subjected to fellatio, alternative explanations should be excluded by taking a detailed medical, dental, and social history; conducting a comprehensive general examination; and, where necessary, undertaking relevant special investigations.

Whenever a complaint of nonconsensual fellatio is made, the head and face must be carefully examined because there may be other injuries around the oral cavity that support the allegation, such as bruises on the face and neck or lacerations of the frenula [101].

Cunnilingus and Anilingus

Definitions

Cunnilingus (cunnilinctus) is the sexual activity in which the female genitalia are licked, sucked, or rubbed by the lips and/or tongue. Anilingus (analingus or "rimming") is the sexual activity in which the anus is licked, sucked, or rubbed by the lips and/or tongue.

Frequency

Consensual

Interviews with 18,876 individuals (44% male) aged 16–59 years in the UK revealed that 66–72% had experienced cunnilingus [102]. Although it is not known how many heterosexual and homosexual couples engage in consensual anilingus, 15% of the women questioned in one study acknowledged erotic feelings with anal stimulation, which, for the majority, included anilingus [103].

Nonconsensual

Cunnilingus is alleged to have occurred in only 3–9% of reported sexual assaults [9, 104]. There are no published reports regarding the number of incidents involving anilingus; anecdotal case material suggests that it is rare.

Legal Implications

In some jurisdictions, penetration of the vagina or anus with the tongue during nonconsensual cunnilingus or anilingus is considered to be legally analogous to nonconsensual penile penetration of the vagina and anus. For example, in England the offense of "assault by penetration" is defined as nonconsensual penetration of the anus or genitalia by an object or a body part [88]. This offense attracts the same maximum penalty as rape.

Forensic Evidence

Method of Sampling

See Sections "Female Genitalia" and "Perianal Area and Anal Canal" for more detailed information.

Forensic Analysis and Persistence Data

Traditionally, the detection of the enzyme amylase on vulval and vaginal swabs was considered confirmatory evidence of the presence of saliva. However, in 1992, a study conducted at the Metropolitan Police Laboratory, London, using vaginal swabs from volunteer female donors who had not participated in cunnilingus revealed high levels of endogenous amylase [105]. Furthermore, amylase has been specifically isolated from cervical mucus [106]. DNA analysis is undertaken on the vulval and/or vaginal swabs. If the assailant's DNA profile is obtained, it can be used to support an allegation of cunnilingus, although, obviously, the precise interpretation will depend on whether the complainant was subjected to other sexual acts that could account for the presence of the DNA (e.g., ejaculation). There are no published persistence data regarding the maximum time it is possible to obtain the assailant's DNA pattern from the female genitalia after cunnilingus/anilingus. It is worth noting that areas of clothing which were in contact with the genitals after such acts can be worth testing as saliva/DNA may have transferred to them.

There are no published data regarding the possibility of obtaining the complainant's DNA STR profile from a swab or saliva sample taken from the assailant's oral cavity or lips after an allegation of cunnilingus or anilingus. Correspondence with numerous forensic biologists has not revealed any cases in which this has been undertaken, and the general consensus among these experts is that it is unlikely that such samples would isolate sufficient material for forensic analysis because of the usual time delay between the sexual act and the obtaining of the samples from the suspect and the limited number of vaginal cells that are likely to be present. Indeed, this presumption appears to be supported by the work of Banaschak et al. [107], who found mixed DNA STR patterns in five samples obtained from five couples who had kissed for 2 min. However, in all cases, the kissing partner's DNA STR pattern was only identifiable in the samples immediately after kissing (maximum 60 s), and no mixed DNA STR patterns were identified when the volunteers were retested at 5 min.

Medical Evidence

Repeated thrusting of the tongue over the edges of the mandibular incisors during cunnilingus or anilingus may cause ulceration of the lingual frenulum, which completely heals within 7 days [108]. Such lesions should be specifically sought during the examination of the suspect's oral cavity when such an act has been described by the complainant or when the precise details of the assault are unknown.

Female Genitalia

Frequency

Penile–vaginal intercourse is the most common sexual act performed between heterosexuals. A UK survey of the sexual practices of 10,492 females aged between 16 and 59 years found that only 5.7% of them had never experienced heterosexual penile–vaginal intercourse [109]. A survey of sexual attitudes and lifestyles undertaken between 1999 and 2001 found that 30% of the men and 26% of the women reported first heterosexual intercourse before the legal age of consent (16 years in the UK) [110].

Legal Implications

Although in English law the legal definition of "rape" relates to nonconsensual penile penetration of the mouth, anus, or vagina, an additional offense of "assault by penetration" covers nonconsensual penetration of the anus or the genitalia by an object or a body part; this offense has the same maximum sentence as rape [88]. In the Republic of Ireland, the law is similar [89]. Other jurisdictions, such as some American states, define all penetrative acts as sexual assaults subcategorized by the degree of force and coercion used. In many jurisdictions, the legal interpretation of "vaginal penetration" refers to penetration of the labia and does not require that the penis actually enter the vagina [88].

The age at which a female can legally give consent for penile–vaginal intercourse varies from country to country; e.g., in England, the age of consent is 16 years [88].

Anatomy

The external female genitalia (vulva) includes the mons pubis, the labia majora, the labia minora, the clitoris, and the vestibule (which incorporates the openings of the urethra and the vagina).

The hymen is the tissue that partially or completely surrounds the opening of the vagina. It appears that all females have hymenal tissue present at birth [111]. The hymen may be annular (encircling the vaginal opening), crescentic (present at the lateral and posterior margins), fimbriated (frilly edged), or, usually after childbirth, present only as interrupted tags or remnants. It is important that the reader refer to atlases that illustrate these variations [112, 113]. There is usually a single opening in the hymen. Uncommon congenital variants include two or more hymenal openings, referred to as septate or cribriform, respectively, and, rarely, complete absence of an opening (imperforate hymen).

The other pertinent anatomic landmarks in this area are the posterior fourchette (where the labia minora unite posteriorly), the fossa navicularis (a relatively concave area of the vestibule bounded anteriorly by the vaginal opening, posteriorly by the posterior fourchette, and laterally by the labia minora), and the anterior fourchette (where the labia minora meet anteriorly and form the clitoral hood).

The skin of the labia majora and the outer aspects of the labia minora is keratinized squamous epithelium, but only the outer aspects of the labia majora are hair bearing. The skin of the inner aspects of the labia minora and the vestibule (including the hymen) is nonkeratinized. This area is usually pink, but in the nonestrogenized child, it may appear red because the skin is thinner and consequently the blood vessels beneath its surface are more apparent [114].

The forensically relevant areas of the internal female genitalia are the vagina and the cervix. The pertinent landmarks are the vaginal fornices (anterior, posterior, right, and left) and the cervical os (opening of the cervical canal).

The vagina and cervix are covered by nonkeratinized squamous epithelium that normally appears pink in the estrogenized female. Occasionally, the columnar endocervical epithelium, which appears red, may be visible around the cervical os because of physiological or iatrogenic (e.g., exogenous estrogens) eversion of the endocervical canal; these are sometimes erroneously referred to as cervical erosions.

Development

The female hypothalamic–pituitary–gonadal axis is developed at the time of birth. During the first 5 days of life, the level of gonadotrophin-releasing hormone (GnRH) rises, with a consequent transient rise in gonadal estrogen, attributable to the withdrawal of placental estrogen [115]. The estrogen causes prominence of the labia and clitoris and thickening and redundancy of the hymen. The neonatal vagina is purported to measure 4 cm in length [114]. Although after 3 months the GnRH levels gradually fall, the estrogenized appearance of the genitalia may persist for the first 2–4 years of life [116, 117]. During this period, the external genitalia gradually becomes less prominent; eventually, the hymen becomes thin and translucent and the tissues appear atrophic; occasionally, the hymen remains thick and fimbriated throughout childhood. The nonestrogenized vagina has relatively few rugae and lengthens by only 0.5–1.0 cm in early childhood [114, 115].

The hypothalamic–pituitary–gonadal axis is reactivated in late childhood, and the breasts and external genitalia alter accordingly. These changes are classically described in terms of their Tanner stage [118]. Under the influence of estrogens, the vagina lengthens to 7.0–8.5 cm in late childhood, eventually reaching its adult length of 10–12 cm [114, 115].

The estrogenized vagina is moist because of physiological secretions. This endogenous lubrication is enhanced with ovulation and with sexual stimulation [119]. The endogenous estrogen levels fall at the time of the menopause and as a consequence of this the vulva and vagina atrophy.

Forensic Evidence

Although legally it is not necessary to have evidence of ejaculation to prove that vaginal intercourse has occurred, forensic science laboratories are frequently requested to determine whether semen is present on the swabs taken from the female genitalia because semen evidence can play a central role in the identification of the assailant. The presence of semen usually confirms that sexual activity has taken place, but the absence of semen on the swabs does not mean that penetration did not occur. The female genitalia should also be sampled if a condom was used during the sexual act (see Section "Lubricants") and if cunnilingus is alleged to have occurred (see Section "Oral Cavity").

It is also important to sample the internal vagina and vulva when only anal intercourse is alleged, this is to exclude the possibility of leakage from the vagina to account for semen in the anal canal (see Section "Perianal Area and Anal Canal").

Method of Sampling

The scientist is able to provide objective evidence in terms of the quantity (determined crudely) and quality of the spermatozoa present and may be asked to interpret the results in the context of the case. When providing expert evidence regarding whether vaginal penetration has occurred, the scientist must be able to rely on the forensic practitioner to obtain the samples in a manner that will refute any later suggestions by the defense that significant quantities of spermatozoa, which were only deposited on the outside of the vulva, could have been accidentally transferred to the high vaginal area during the medical examination [11]. It is worth noting that there has been no research to support or refute this hypothesis.

Currently, there is no internationally agreed method for obtaining the samples from the female genital area. The following method has been formulated by experienced forensic practitioners and forensic scientists in England to maximize the recovery of spermatozoa while considering these potential problems [93]:

1. Any external (sanitary napkins or pads) or internal (tampons) sanitary wear is collected and submitted for analysis with a note about whether the item was in place during the sexual act and whether other sanitary wear has been in place but discarded since the incident.
2. Two swabs are then used sequentially to sample the vulva (i.e., the labia majora, the labia minora, and the vestibule) and the perineum. Particular attention must be paid to sampling the interlabial folds. Even though traditionally these swabs have been labeled "external vaginal swab," they should be labeled as "vulval swab" to clearly indicate the site of sampling.
3. Moist stains should be recovered on dry swabs. However, if the vulval area or any visible staining appears dry, the double-swab technique should be used [44] (see "Skin" Section "Method of Sampling").
4. The labia are then separated, and two sequential dry swabs are used to comprehensively sample the lower vagina. These are labeled "low vaginal swabs."
5. An appropriately sized transparent speculum is then gently passed approximately two-thirds of the way into the vagina; the speculum is opened, and any foreign

bodies (e.g., tampons or condoms) are removed and submitted for analysis. Then, two dry swabs are used to comprehensively sample the vagina beyond the end of the speculum (particularly the posterior fornix where any fluid may collect). These are labeled "high vaginal swabs."

6. Where possible, two endocervical samples are then obtained. At this point, the speculum may be manipulated within the vagina to locate the cervix.

Lubricant from a single-use sachet or tube or sterile water can be used to lubricate the speculum [16]. If doctors use a lubricant, they must note its use on the forms returned to the forensic scientist.

In the process of sampling the vagina, the speculum may accumulate body fluids and trace evidence. Therefore, the used speculum should be retained, packaged separately, and stored in accordance with local policy. If the speculum is visibly wet on removal, swabbing may be undertaken to retrieve visible material. If storage space is restricted, swab the instrument and retain the swabs instead.

Additional methods of semen collection (e.g., aspiration of any pools of fluid in the high vagina) should not be necessary if dry swabs are used to sample the vagina in the manner described. Furthermore, there are no data to confirm that vaginal washings retrieve spermatozoa more effectively than vaginal swabs.

In exceptional circumstances (e.g., genital injury or age of the examinee), it may not be possible to pass a speculum to obtain the "high vaginal" and endocervical swabs. On these occasions, two dry swabs should be inserted sequentially into the vagina under direct vision, avoiding contact with the vestibule and hymen. An attempt should then be made to comprehensively sample the vagina by gently rotating and moving each swab backward and forward. These swabs should be labeled "vaginal swabs." Unfortunately, in such circumstances, it is impossible to be certain that the high vaginal swab was not contaminated from semen in the low vagina, which could be there because of drainage from external ejaculation.

Forensic Analysis

Spermatozoa

Some guidelines recommend that the forensic practitioner performs an immediate microscopic examination of a wet mount of the material obtained from the vaginal fornices to identify motile spermatozoa on the basis that the presence and motility of spermatozoa may help determine whether recent vaginal ejaculation had occurred. However, a considerable body of opinion does not commend this practice [120]. Forensic science laboratories have specialist extraction procedures, staining techniques, and microscopic equipment to maximize spermatozoa recovery and facilitate identification. A survey of 300 cases in which spermatozoa were eventually identified found that they were only detected in four of the cases in the native preparation (before the application of specialist stains) [121].

When nonconsensual penile–vaginal penetration is alleged, the samples are examined microscopically by the forensic scientist to identify spermatozoa, and DNA analysis is performed on any spermatozoa found if deemed necessary.

Seminal Fluid

Acid phosphatase is found abundantly in the prostate gland and, therefore, in seminal fluid. In most laboratories, the Brentamine test [122] is used to detect acid phosphatase. However, acid phosphatase is also found to a lesser extent in vaginal secretions, so further confirmatory testing is necessary to determine whether the fluid is semen. Usually this is microscopy to visualize spermatozoa but under some circumstances (e.g., vasectomy) spermatozoa may be absent from semen.

If no spermatozoa are detected, an attempt is made to confirm the presence of semen by other means. The microscopic identification of seminal choline crystals can be carried out. Seminal choline is present in high concentrations in seminal fluid, and the choline crystals can be precipitated by the addition of reagents [123]. There are also electrophoretic techniques by which seminal fluid can be identified [124]. Some laboratories now use immunological tests such as Seratec prostate-specific antigen (PSA) [13, 125, 126] or The Rapid Stain Identification (RSID™) test for semen [127]. The latter is an immunochromatographic strip test, which uses two monoclonal antibodies specific for human semenogelin.

Because the PCR DNA techniques are now so sensitive, it is often possible to obtain a DNA profile from cellular material present in the seminal fluid even when no spermatozoa are present. FISH technology can also be used to identify small amounts of male epithelial cells that can then be isolated and DNA profiled [128–130].

Blood

A retrospective survey carried out at the Metropolitan Police Forensic Science Laboratory (MPFSL) found that nearly one-third of the vaginal swabs received at the laboratory were blood stained [10]. Whenever bleeding is noted during the medical examination, the forensic practitioner should communicate to the scientist any possible source for the bleeding. In the MPFSL study, the examining doctors attributed 22% of the blood-stained swabs to menstruation and 10% to female genital trauma. In the remaining cases, no explanation for the bleeding was given. In these cases, the presence of blood must be interpreted with caution, particularly if in small quantity, because traces of uterine blood may be present at any time of the cycle [10] and, currently, there is no accepted method of differentiating between traumatic and uterine blood [131]. Furthermore, even traumatic bleeding may result from consensual sexual acts (see "Female Genitalia" Section "Medical Evidence"). On rare occasions, assailants injure their penises during a sexual act, and this may be the source of blood found in the vagina.

Persistence Data

Research conducted at the MPFSL has found that after vaginal intercourse, spermatozoa should be found in the vagina for 24 h, are likely to be found up to 3 days later, and occasionally, are found 7 days later [122, 132]. Longer times for persistence are the exception rather than the rule. Semen will persist in dead bodies for much longer time intervals.

The quantity of semen in the vagina will diminish progressively with time, usually as a result of drainage. The posture and activity of the complainant subsequent to the act are likely to affect this. Similarly, washing, douching, or bathing may accelerate the loss of semen. Drainage of semen from the vagina may also result in soiling of intimate clothing items worn at the time, and these can prove valuable sources of body fluids.

It has been observed that spermatozoa can be isolated for longer periods in the endocervix. Graves et al. [125] report that spermatozoa were isolated from the endocervix 17 days after intercourse. Studies that compared paired swabs from the vagina and cervix have found that 2 days or more after vaginal ejaculation there is a larger quantity of spermatozoa on endocervical swabs compared with the vaginal swabs [133]. Therefore, it is recommended that where possible, an endocervical swab be taken in addition to the swabs from the vagina.

Although seminal choline has only been found on vaginal swabs up to 24 h after vaginal ejaculation [134], using FISH technology, Y chromosome-intact cells have been identified on postcoital vaginal swabs 7 days after sexual intercourse with ejaculation [135].

There is interest in the possibility of determining the timing of intercourse by changes in spermatozoa. Spermatozoa may remain motile in the vagina for up to 24 h and longer in the cervical mucosa [69, 136, 137], but the periods for persistence are extremely variable. For example, Rupp [138] observed that motile spermatozoa persisted longer in menstruating women, but added that identification is hindered by the presence of red blood cells, and Paul [139] reported that the period of spermatozoa motility ranged from 1 to 2 h at the end of the menstrual cycle to as long as 72 h at the time of ovulation.

However, the morphology of the spermatozoa does show more consistent temporal changes. In particular, the presence of large numbers of spermatozoa with tails is indicative of recent intercourse. Most tails are lost from semen in the vagina within 6–9 h of intercourse. The longest time after intercourse that spermatozoa with tails have been found on "external vaginal" (vulval) swabs is 33 and 120 h on internal vaginal swabs [94]. A full DNA STR profile matching the assailant should be obtainable from vaginal swabs taken up to 24 h postcoitus; partial DNA STR profiles are more likely to be obtained between 24 and 48 h postcoitus (Elliott K, personal communication, 2002).

Medical Evidence

Examination Methods

The forensic practitioner should inspect the mons pubis and note the color, coarseness, and distribution (Tanner stages 1–5) of any pubic hair. A note should also be made if the pubic hair appears to have been plucked (including bleeding hair follicles), shaved, cut, or dyed.

Then the vulval area must be carefully inspected before the insertion of a speculum, because even gentle traction on the posterior fourchette or fossa navicularis during a medical examination can cause a superficial laceration at these sites. Whenever possible, the vagina and cervix should be inspected via the transparent speculum after the high vaginal samples have been obtained. Colposcopy and the application of toluidine blue dye are two specialist techniques used by some forensic practitioners during female genitalia examinations.

Colposcopy

A colposcope is a free-standing, binocular microscope on wheels that is most commonly used for direct visualization of the cervix (using a bivalve speculum) after the detection of abnormal cervical cytology. Many centers, particularly those in the USA, advocate the use of the colposcope for external and, where relevant, internal genital and/or anal assessments of complainants of sexual assault.

The colposcope undoubtedly provides considerable advantages over gross visualization. First, it provides magnification (5–30 times) and greater illumination, enabling detection of more abnormalities. Slaughter and Brown [140] demonstrated positive colposcopic findings in 87% of female complainants of nonconsensual penile penetration within the previous 48 h, whereas gross visualization has historically identified positive genital findings in only 10–40% of cases [56–58, 141, 142].

Second, with the attachment of a still or DVD video camera, the colposcope allows for a truly contemporaneous, permanent video/photographic record of the genital/anal findings without resorting to simultaneous dictation, which has the potential to distress the complainant. If a DVD video is used, it will document the entire genital examination and will show any dynamic changes, such as reflex anal dilatation. If appropriate, the medical findings can be demonstrated to the complainant and carer; some teenagers have apparently appreciated the opportunity to have any fears of genital disfigurement allayed by the use of this equipment.

Finally, if a remote monitor is used, the whole examination can be viewed by another doctor for corroboration or teaching purposes without additional parties having to be present during the intimate examination. This facility is obviously more pertinent when DVD video recording is not available.

Obviously, it is important that in all cases the colposcopic evidence be interpreted in the context of the information that is currently available regarding colposcopic assessments after consensual sexual acts [143–148].

Toluidine Blue

Toluidine blue stains breaches of the keratinized squamous epithelium and can highlight lacerations of the posterior fourchette that are not apparent on gross visualization [149, 150]. Use of toluidine blue increased the detection rate of posterior fourchette lacerations from 4 to 58% in adult (older than 19 years) complainants of nonconsensual vaginal intercourse, from 4 to 28% in sexually abused adolescents (11–18 years old), and from 16.5 to 33% in pediatric sexually abused patients (0–10 years old) [150, 151].

The same frequency of posterior fourchette lacerations has been identified using the stain in adolescents after consensual penile penetration and nonconsensual sexual acts [150]. In contrast, adult complainants of nonconsensual vaginal intercourse and sexually abused children had significantly more lacerations demonstrable by toluidine blue staining than control groups [150], although such staining does not identify lacerations that cannot be detected using a colposcope [140]. Therefore, if a colposcope is not available, toluidine blue may be an adjunct to the genital assessment of prepubertal and adult complainants of vaginal penetration [150, 151]. Furthermore, some centers use the stain during colposcopy to provide a clear pictorial presentation of the injuries for later presentation to juries [140].

Vulval swabs for forensic analysis must be taken before the stain is applied. Toluidine blue (1%) is then painted on the posterior fourchette, using a swab, before any instrumentation. After a few seconds, the residual stain is removed with lubricating jelly and gauze [149]. The patient may experience some stinging at the application site. The time parameters within which the use of toluidine blue is beneficial in highlighting injuries have not been identified.

Injuries

Penile–vaginal penetration is the most frequent sexual act performed by heterosexual couples and genital injuries have been reported following consensual and nonconsensual acts. Therefore, an accurate description of the site and type of any genital injury is essential as genital injuries can provide supportive evidence of sexual contact or penetration. However, there is insufficient data to determine whether any particular pattern or type of genital injury can determine whether the sexual act was consensual. Furthermore, a lack of genital injury does not mean that penetration did not take place or that the complainant consented to the sexual acts. It is not inevitable that a woman will notice bleeding following the first act of peno-vaginal penetration: a retrospective survey of the first coital experience of a 100 women found that only 56% of them recalled bleeding following the first sexual act although the source of the bleeding was not identified [152].

External Genitalia

For penile penetration of the vagina to occur, the penis must first pass between the labia minora and then through the hymenal opening. The apposition of the penis and the posterior fourchette in the majority of sexual positions means that the posterior fourchette and fossa navicularis may be stretched, rubbed, or receive blunt trauma as vaginal penetration is achieved. Lacerations and abrasions at the posterior fourchette and fossa navicularis have all been described after consensual and nonconsensual sexual activity, although in many cases, the examinations were enhanced by the use of toluidine blue or a colposcope [143–146, 149, 150, 153, 154]. Bruises have also been described at these sites following nonconsensual sexual acts but are rarely described at these sites following consensual sexual acts [144, 145].

Injuries to the labia (majora and minora) have been less frequently identified following consensual sexual acts compared to nonconsensual [145, 146, 155, 156]. However, the fact that injuries have been described at these sites following consensual sexual intercourse means that these injuries are also nondiscriminatory.

Healing of lacerations of the external genitalia is predominantly by first intention, with no residual scarring being detected at follow-up assessments [153, 157]. Nonetheless, scarring may occur occasionally in these areas, but it is important not to mistake a linear vestibularis, a congenital white line identified in the fossa navicularis (present in 25% of neonates), for a scar [158].

Hymen

The hymen must be examined in detail after an allegation of a nonconsensual penetrative act. When the hymen is fimbriated, this assessment may be facilitated by the gentle use of a moistened swab to visualize the hymenal edges. When the hymenal opening cannot be seen at all, application of a few drops of warm sterile water or saline onto the hymen will often reveal the hymenal edges. Foley catheters are also a useful tool to aid hymenal visualization in postpubertal females [159]. A small catheter is inserted through the hymenal opening, the balloon is then inflated with 10–20 mL of air, and the catheter is gently withdrawn so that the inflated balloon abuts the hymen. The balloon is deflated before removal. This procedure is well tolerated by the examinee. Obviously, in the acute setting, none of these maneuvers should be attempted until the relevant forensic samples have been retrieved.

Acute hymenal injuries (bruises, lacerations, abrasions, swelling, and redness) have been described following consensual and nonconsensual acts [146, 153] and may occur anywhere on the hymenal rim [160]. However, in contrast to popular myth, it is not inevitable for the hymen to be injured during the first sexual act. One retrospective survey of the acute injuries noted among adolescent complainants of sexual assault (aged 12–17 years) found that hymenal injuries were only identified in 56% of the subgroup of complainants that denied previous sexual activity [161]. The lack of injury to the hymen following the first sexual act is attributed to the natural elasticity of the postpubertal hymen [162].

Hymenal bruises, abrasions, reddening, and swelling completely disappear within a few days or weeks of the trauma [153, 160]. Even hymenal lacerations may partially or completely reunite [160].

When acute hymenal injuries have healed, there may be no evidence to determine whether the patient has previously experienced vaginal penetration. Kellogg and colleagues reviewed the clinical records (including photo-colposcopic slides) of 36 pregnant adolescent (12.3–17.8) girls who presented for sexual abuse evaluations. The genital examination was reported to be normal or nonspecific in 22 (64%) of the cases [163]. This could be because the hymen was not significantly injured during the sexual activity or because any injuries had healed.

Goodyear and Laidlaw [164] conclude that, "it is unlikely that a normal-looking hymen that is less than 10 mm in diameter, even in the case of an elastic hymen, has previously accommodated full penetration of an adult finger, let alone a penis." However, there is no objective evidence on which to base this conjecture, and it is not known whether measuring the hymenal opening using a digit, or other previously measured object, in the clinical setting when the practitioner is particularly anxious not to cause the patient any distress accurately reflects what the hymen could have accommodated during a sexual assault. Furthermore, the similarity between the dimensions of the hymenal opening among sexually active and nonsexually active postpubertal females [165] makes it impossible for the physician to state categorically that a person has ever had prior sexual intercourse unless there is other supportive evidence (pregnancy, spermatozoa on a high vaginal swab; see "Female Genitalia" Section "Forensic Evidence") [166].

Vagina and Cervix

Bruises, abrasions, and redness to the vagina and cervix have been described following consensual sexual acts [144, 146]. Fraser et al. [147] described the macroscopic and colposcopic variations in the epithelial surface of the "vagina" and cervix in healthy, sexually active women (aged 18–35 years). They documented changes in the epithelial surface in 56 (17.8%) of the 314 inspections undertaken: 6 were located at the introitus, 26 in the middle or lower thirds of the vagina, 8 on the fornical surfaces of the cervix, 14 in the vaginal fornices, and 2 involved generalized changes of the vaginal wall. The most common condition noted was petechiae. The more significant conditions noted were three microulcerations, two bruises, five abrasions, and one mucosal tear. The incidence of these conditions was highest when the inspections followed intercourse in the previous 24 h or tampon use.

Lacerations and ruptures (full-thickness lacerations) of the vagina have also been described in the medical literature after consensual sexual acts [167–169]. They are most commonly located in the right fornix or extending across the posterior fornix; this configuration is attributed to the normal vaginal asymmetry whereby the cervix lies toward the left fornix, causing the penis to enter the right fornix during vaginal penetration [169]. Factors that predispose to such injuries include previous vaginal surgery, pregnancy, and the puerperium, postmenopause, intoxication of the female, first act of sexual intercourse, and congenital genital abnormalities (e.g., septate vagina) [167]. Although most vaginal lacerations are associated with penile penetration, they have also been documented after brachiovaginal intercourse (fisting) [169], vaginal instrumentation during the process of a medical assessment [166], and the use of plastic tampon inserters [170]. Vaginal lacerations have been documented without any direct intravaginal trauma after a fall or a sudden increase of intra-abdominal pressure (e.g., lifting a heavy object) [169].

Injuries of the vagina and cervix have been noted during the examinations of complainants of sexual assault. Slaughter et al. [153] describe 26 colposcopically detected vaginal injuries among the 213 complainants who had genital trauma identified. These were described as “tears” ($n = 10$), bruises ($n = 12$), and abrasions ($n = 4$). Other articles that considered only macroscopically detectable lesions found vaginal “injuries” in 2–16% of complainants of nonconsensual penile vaginal penetration [171, 172]. However, one study included “redness” as a vaginal injury when, in fact, this is a nonspecific finding with numerous causes. Bruises and lacerations of the cervix have been described as infrequent findings after nonconsensual sexual acts [53, 173, 174]. In one article, the injuries related to penetration by a digit and by a “knife-like” object.

When a vaginal laceration may have been caused by an object that has the potential to fragment or splinter, a careful search should be made for foreign bodies in the wound [167] (this may necessitate a general anesthetic), and X-rays should be taken of the pelvis (anteroposterior and lateral), including the vagina, to help localize foreign particles [175]. Any retrieved foreign bodies should be appropriately packaged and submitted for forensic analysis.

Male Genitalia

During examination of the male genitalia, the forensic practitioner is expected to document any features that could assist with subsequent identification of the assailant, to note any acquired or congenital conditions that could make an alleged sexual act impossible, to describe in detail any injuries that could relate to a sexual act, and to retrieve any forensic evidence. Although the specifics of the medicolegal assessment of the male genitalia are case dependent, the principles of the examination, whether of the complainant or of the defendant, are the same.

Anatomy and Physiology

Penile Size

Forensic practitioners may be asked to provide evidence on the size of a defendant's penis in the flaccid state to support a hypothesis that a certain sexual act could not have occurred because of intergenital disproportion between the complainant and the defendant. However, such measurements are unhelpful because it is not possible to predict the maximum erectile size from the flaccid length, and there is "no statistical support for the "phallic fallacy" that the larger penis increases in size with full erection to a significantly greater degree than does the smaller penis" [176]. Furthermore, even when the erect penis is measured during automanipulation or active coition, the measurements are recognized to be unreliable [176].

Erections

Forensic practitioners may also be asked to comment on a person's ability to achieve a penile erection, particularly if the male is young or elderly. Masters and Johnson [176] note that during their research, "penile erection has been observed in males of all ages ranging from baby boys immediately after delivery to men in their late eighties"; they report that one 89-year-old study subject was able to achieve a full penile erection and ejaculate. Therefore, it is not possible to reach a conclusion regarding erectile efficiency based on age alone. When a defendant reports erectile dysfunction, the expert opinion of a urologist should be sought.

Penile erection may result from visual stimulation (including fantasy) or tactile stimulation. The penis, scrotum, and rectum are all sensitive to tactile stimulation [176], which may explain why involuntary penile erections can be experienced by males subjected to nonconsensual anal intercourse.

Semen Production

Semen is not produced until the male experiences puberty, which usually begins between 9 and 14 years of age [177]. Semen consists of seminal fluid (produced by the prostate) and spermatozoa. The normal volume of a single ejaculate is between 2 and 7 mL, and it will contain approximately 50–120 million spermatozoa per milliliter. There are numerous congenital and acquired causes for impaired spermatogenesis [178], resulting in either decreased numbers (oligozoospermia) or absence of (azoospermia) spermatozoa. Both conditions may be permanent or transitory depending on the underlying cause. It is not possible to determine whether spermatozoa are present in the ejaculate without microscopic assessment. However, analysis of a defendant's semen is not a routine part of the forensic assessment.

Forensic Evidence

After an allegation of fellatio, swabs from the complainant's penis can be examined for saliva, and an amylase test may be carried out (see "Cunnilingus and Anilingus" Section "Forensic Analysis and Persistence Data"). It is worth remembering that amylase may also be present and detectable on underwear that was in contact with the penis after the deposition of the saliva [45]. DNA profiling can be carried out on the swabs or clothing. When an allegation of vaginal or anal intercourse is made, penile swabs from the suspect can be examined for cells, feces, hairs, fibers, blood, and lubricants.

It should be noted that vaginal fluid from recent previous intercourse, unrelated to the allegation, may be detected by DNA analysis of swabs taken from the unwashed penis (Harris E, personal communication, 1998). In one reported case, DNA from the complainant's boyfriend was found on the suspect's penis [179].

Sampling Method

Data collected by the MPFSL between 1987 and 1995 [94] have shown that after vaginal intercourse, cellular material from the complainant can be recovered from the coronal sulcus (groove around the penis just below the glans) even if the suspect has washed or bathed since the offense. Swabs taken from the meatus and urethra are not suitable for microscopic assessment because some male urethral cells can be similar to vaginal cells [10]. Therefore, current recommendations [93] advise that when intercourse (vaginal, anal, or oral) is alleged, two swabs (the first wet, the second dry) should be obtained sequentially from the penile shaft and, if present, external foreskin, two swabs (the first wet, the second dry) should be taken sequentially from the coronal sulcus and internal foreskin (if present), and the final two swabs (the first wet, the second dry) from the glans. The swabs must be labeled accordingly, and the order in which the samples were obtained must be relayed to the scientist. The same samples are also taken if it is believed that a lubricant or condom has been used during a sexual act or if the assault involved fellatio or anal intercourse.

Forensic Analysis

Microscopic and Biochemical Analyses

Such analyses of the penile swabs may be undertaken to identify cellular material, blood, or amylase. There is as yet no reliable way of determining the origin of any cellular material observed (i.e., vaginal epithelial vs. buccal epithelial). However, mRNA profiling has been proposed as a new method of body fluid identification, and a lot of research is being carried out in this area [34, 180]. When the allegation is of anal intercourse, swabs that are discolored by fecal material can be analyzed for urobilinogen and examined microscopically for vegetable matter.

Assailant Identification

DNA STR profiling of body fluids on the penis is now the method of choice used to provide evidence of penile–vaginal/oral/anal contact. It has proved particularly useful when multiple assailants have had intercourse with a single complainant [179], because DNA STR profiles matching the other assailants may also be found on the penile swabs taken from one assailant.

Persistence Data

Female DNA profiles have been obtained on penile swabs up to 24 h postcoitus [181]. Blood and feces have been recovered from penile swabs taken 15 and 18 h, respectively, after the incident (for saliva, see Section "Fellatio" and [10]).

Medical Evidence

When obtaining the relevant forensic samples, the forensic practitioner should inspect the male genitalia with particular reference to the following points:

1. Pubic hair should be described in terms of its coarseness, distribution (Tanner stages 1–5), and color. A note should be made if the pubic hair appears to have been plucked (including bleeding hair follicles), shaved, cut, or dyed.
2. Congenital abnormalities, such as microphallus and cryptorchidism. Penile length in the flaccid state is said to vary from 8.5 to 10.5 cm (measured from the anterior border of the symphysis along the dorsal surface to the distal tip of the penis), with a documented range of 6–14 cm [176].
3. Acquired abnormalities, such as circumcision, Peyronie's disease, balanitis xerotica obliterans, vasectomy scars, phimosis, tattoos, and piercing.
4. Signs of infection, such as warts, discharge, erythema, and vesicles.
5. Foreign bodies may be worn around the base of the penis, sometimes also encircling the scrotum, in an attempt to increase and sustain penile tumescence. Such devices may result in local and distal genital trauma (penile tourniquet syndrome) [182]. In several case reports, children have had human hairs wrapped around the penis; these hairs may be virtually invisible because of edema or epithelialization [183]. Kerry and Chapman [184] have described the deliberate application of such a ligature by parents who were attempting to prevent enuresis.
6. Assessment of injuries. After consensual sexual intercourse, lacerations of the foreskin and frenulum, meatitis, traumatic urethritis, penile edema, traumatic lymphangitis, paraphimosis, and penile "fractures" have all been described [185–187a]. Accidental trauma is more common when there is a preexisting abnormality, such as phimosis [185]. Skin injury may be incurred if the genitals

are deliberately bitten during fellatio [185]. Although the precise incidence of male genital trauma after sexual activity is unknown, anecdotal accounts suggest that it is rare to find any genital injuries when examining suspects of serious sexual assaults [188].

In children the genitalia may be accidentally or deliberately injured, and the latter may be associated with sexual abuse [189]. Bruises, abrasions, lacerations, swelling, and burns of the genitalia of prepubescent males have all been described [189, 190].

Perianal Area and Anal Canal

Definitions

Buggery is a lay term used to refer to penile penetration of the anus (anal intercourse) of a man, a woman, or an animal (also known as bestiality). Sodomy relates to anal intercourse between humans only.

Frequency

Consensual

Although anal intercourse among heterosexuals is the least common component of the sexual repertoire, it has been experienced on at least one occasion by 13–25% of heterosexual females surveyed [86–103, 191], and it was described as a regular means of sexual gratification for 8% of women attending one gynecologist [103]. Among 508 men who reported having had a same-gender sexual experience at some stage in their lives, 33.7% reported insertive anal intercourse, and 35.4% had experienced receptive anal intercourse. More men had experienced both practices than had been in exclusively receptive or insertive roles [192].

Nonconsensual

Anal intercourse was reported by 5–16% of females who described having been sexually assaulted [9, 193]. Although it may be the only sexual act performed, it is more frequently combined with vaginal and oral penetration [9, 193]. Fewer data are available regarding sexual assaults on males, although Hillman et al. [194, 195] reported that penetrative anal intercourse was described by 75–89% of the male complainants they studied.

Legal Implications

In English law, the legal definition of "rape" relates to nonconsensual penile penetration of the anus (or mouth, or vagina) and an additional offense of "assault by penetration" covers nonconsensual penetration of the anus by an object or a body part; both of these offenses have the same maximum sentence [88]. In the Republic of Ireland, rape under Section 4 of the Criminal Law amendment Act states that a sexual assault that includes penetration (however slight) of the anus (or mouth) by the penis is an offense with the same maximum sentence as rape [89].

Anatomy and Physiology

An understanding of the normal anatomy and physiology of the perianal area and anal canal is important for the reliable description and interpretation of the medical findings after allegations of anal penetrative acts. Unfortunately, varying definitions have resulted in considerable confusion, such that there is no consensus among forensic practitioners about the nomenclature that should be used in describing injuries to this area. Therefore, a brief overview of the relevant information is given in the remaining subheadings, together with references to more substantive texts.

Anus

The anus refers not to an actual anatomical structure but to the external opening of the anal canal. The skin that immediately surrounds the anus is variously referred to as the anal verge or anal margin [2]. Because the anal canal can evert and invert as the anal sphincters and pelvic floor muscles relax and contract, the anal verge/margin is not a fixed, identifiable landmark.

Perianal Area

The perianal area is a poorly defined, approximately circular area that includes the folds of skin encircling the anus. It is covered by skin that is often hyperpigmented when compared with the skin on the buttocks, although this varies with age and ethnicity [196].

Anal Canal

Although the anal canal has been variously defined, the definition that has practical clinical forensic value is that of the anatomical anal canal, which extends from the anus to the dentate line. The dentate line refers to the line formed either by the bases of the anal columns (most distinct in children) or, when these are not apparent, by the lowest visible anal sinuses [197]. The average length of the anatomical anal canal in adults (age range 18–90 years) is only 2.1 cm, with a range of 1.4–3.8 cm in males and 1.0–3.2 cm in females [198]. Between the epithelial zones of the anal canal and the rectum is the anal transitional zone, which is usually located in the region of the anal columns and is purple [199].

The anal canal, as previously defined, is lined by nonkeratinized squamous epithelium and is salmon pink in the living [196]. It is sensitive to touch, pain, heat, and cold to just above the dentate line [197]. The anus and lumen of the anal canal usually appear as an asymmetric Y-shaped slit when viewed via a proctoscope (anoscope). The folds of mucosa and subcutaneous tissue (containing small convulated blood vessels surrounded by connective tissue) between the indentations of the Y are referred to as the anal cushions. Although this appearance is usually obscured externally by the folds of skin on the perianal area, it may become apparent if the patient is anesthetized or as the anus dilates.

Rectum

The rectum extends from the anal transitionary zone to the sigmoid colon and is 8–15 cm long. It is lined by typical intestinal mucosa and is red in the living. The rectum has only poorly defined dull sensation [197].

Anal Sphincters and Fecal Incontinence

Although numerous muscles encircle the anal canal, the two that are forensically significant are the internal and the external anal sphincters.

Internal Anal Sphincter

This sphincter is a continuation of the circular muscle coat of the rectum and extends 8–12 mm below the dentate line. In the normal living subject, the internal anal sphincter is tonically contracted so that the anal canal is closed. The internal sphincter is supplied by autonomic nerve fibers and is not considered to be under voluntary control. Thus, although it appears to contract during a digital assessment of voluntary anal contraction, it is presumed to result from its compression by the surrounding external sphincter fibers [199].

External Anal Sphincter

This sphincter encircles the internal sphincter but extends below it, ending subcutaneously. The lower edges of the external and internal sphincters can be distinguished on digital palpation. Although this sphincter is tonically contracted in the resting state, this contraction can be overcome with firm pressure [199]. If the patient is asked to contract the anus during a digital assessment, the external sphincter can be felt to ensure contraction and closing of the anus tightly. However, because the muscle fibers are predominantly the slow-twitch type, a maximum contraction of the external sphincter can only be maintained for approximately 1 min [200].

Fecal continence is maintained by several factors, the relative importance of which has not been fully elucidated. Currently, the most important factor is the angulation between the rectum and the anal canal, which is maintained at a mean of 92° by continuous contraction of the puborectalis muscles, located above the external sphincter. Both sphincters have supportive roles in maintaining fecal continence [197], and their disruption can result in incontinence (see Section “Anal Sphincter Tone”).

Forensic Evidence

The presence of semen in the anus or rectum of a male complainant can be corroborative evidence of alleged anal intercourse in conjunction with the presented history and possible physical findings.

The same is only true for a female complainant if no semen is detected in the vagina, because semen has been found on rectal and anal swabs taken from women who described vaginal intercourse only. It is postulated that the presence of semen in these cases results from vaginal drainage [201].

Swabs should also be taken if a condom or lubricant was used during the sexual assault and if anilingus is alleged (see Sections “Cunnilingus and Anilingus” and “Lubricants”).

Method of Sampling [93]

Two samples must first be obtained from the perianal area. Just as when sampling the skin elsewhere, if the perianal skin is moist, the stain should be retrieved on dry swabs. If there is no visible staining or the stain is dry, the double-swab technique should be used [44]. The forensic practitioner should use as many swabs as are necessary to remove any visible stain (repeating moistened swab followed by dry swab). If no stain is visible, two swabs will suffice (the first wet, the second dry). Although not specifically defined for forensic purposes, the perianal area should be considered as an area with a radius of 3 cm from the anus. The swabs are then placed in sheaths without transport medium. Even though traditionally these swabs have been labeled “external anal swab,” they should be labeled as “perianal swab” to clearly indicate the site of sampling. The anal canal is then sampled by passing a wet swab and then a dry swab, sequentially, up to 3 cm through the anus. The proctoscope (anoscope) is then passed 2–3 cm into the anal canal, and the lower rectum is sampled using a dry swab. As discussed previously, when examining female complainants of anal intercourse alone, swabs should also be obtained from the vagina.

Water-based lubricant from a single-use sachet (Pedicat® or KY® Lubricating Jelly) may be used to moisten the proctoscope to facilitate its insertion into the anus. If lubricant is used, it should be noted on the form returned to the forensic scientist.

In the process of sampling the rectum/anal canal, the proctoscope may accumulate body fluids and trace evidence. Therefore, the used proctoscope should be retained, packaged separately, and stored in accordance with local policy.

If the proctoscope is visibly wet on removal, swabbing may be conducted to retrieve visible material. If storage space is restricted, then the instrument should be swabbed and the swabs retained instead.

Stool samples and toilet paper need not be collected routinely because the other samples described should be adequate for laboratory requirements.

Forensic Analysis

Microscopic examination for spermatozoa (or other tests if no spermatozoa are present, see Section "Seminal Fluid") is initially undertaken, followed by DNA analysis if any body fluids are identified.

Lubricant and saliva analysis are discussed in Sections "Lubricants" and "Cunnilingus and Anilingus", respectively.

Persistence Data

Under normal circumstances, semen is unlikely to persist in the anus for more than 24 h. The maximum recorded interval between the act of anal intercourse and the identification of spermatozoa on a rectal swab is 96 h [202]. However, in one exceptional case in which a female remained prone in the hospital for several days because of injuries sustained during a sexual assault, semen was detected on anal swabs taken 113 h after the act of anal intercourse [202].

Swabs should be taken even if the complainant has defecated since the assault. An unpublished review of 36 MPFSL cases of alleged anal intercourse in which the complainant had defecated before the examination found that in six cases (four female and two male) the internal/external anal swabs were still positive for spermatozoa, although only a few were present; one of these subjects, a male, had a positive external anal swab 52 h after the anal intercourse (Allard J, personal communication, 1998). Anal swabs have produced a positive DNA STR analysis up to 48 h after the incident (Elliott K, personal communication, 2003).

Medical Evidence

Anal and rectal injuries have been described in numerous papers following consensual and nonconsensual penile/object anal penetration [144, 146, 203]. Hilden and colleagues found that nonconsensual anal penetration is a risk factor for genitoanal injuries [204]. Therefore, when an allegation of anal penetration is made, the perianal skin, anal canal mucosa, and, when tolerated, the lower portion of the rectum should be inspected carefully with the aid of a proctoscope/anoscope. This inspection can be done simultaneously with the retrieval of the forensic evidence. However, it is important to note the nature and size of any perianal injuries before a proctoscope/anoscope is used to be able to refute later suggestions that any perianal injury was iatrogenic. A colposcope with or without an injury enhancing stain (toluidine blue) may be used during the inspection of the perianal area.

An accurate description of the site and type of any injury is essential as perianal and rectal injuries can provide supportive evidence of sexual contact or penetration. However, there is insufficient data to determine whether any particular pattern or type of perianal or rectal injury can determine whether the sexual act was consensual. Furthermore, a lack of perianal or rectal injury does not mean that penetration did not take place or that the complainant consented to the sexual acts as it is generally accepted that with gradual dilatation and lubrication, consensual penile anal intercourse can be performed without any resultant injury [103, 205].

Perianal Injuries

Tears (anal fissures and lacerations), abrasions, redness, and swelling of the "anus" have been described following consensual and nonconsensual acts [144, 146, 205]. However, the lack of detail regarding the nature of the consensual sexual acts makes it difficult to determine whether the findings were coincidental, i.e., due to nonsexual causes or directly related to a sexual act. For example, anal fissures may result from numerous other means that are unrelated to penetrative trauma, including passage of hard stools, diarrhea, inflammatory bowel disease, sexually transmitted diseases, and skin diseases [206, 207]. Bruises appear to be infrequent findings following consensual sexual acts. However, the lack of data on perianal injuries make it impossible to determine whether this is a significant observation.

Anal Sphincter Tone

The forensic practitioner may be asked about the effects that a single episode or repeated episodes of anal penetration have on anal sphincter tone and subsequent continence of feces. In terms of single anal penetrative acts, partial tears and complete disruptions of the anal sphincters have been described after a single traumatic sexual act [208, 209]; one case was caused by pliers and the others by brachioproctic intercourse (fisting). However, it is not clear from these case reports whether the sexual practices were consensual or nonconsensual. The two patients who were described as having complete disruption of the sphincters both developed fecal incontinence. There is a case report of "multiple ruptures" of the internal anal sphincter with resultant fecal incontinence after nonconsensual anal penetration with a penis and fist [210].

Regarding repeated acts of anal penetration, the studies are conflicting. A study of 129 heterosexual women who gave a history of anal intercourse found no reports of "gross fecal incontinence" [86]. Similarly, Chun et al. [211] found that although the 14 anoreceptive homosexual males studied had significantly lower resting anal canal pressures when compared with the control group (ten nonanoreceptive heterosexual males), there were no complaints of fecal incontinence by the study subjects. In contrast, Miles et al. [212] found a significant increase in fecal incontinence or urgency (requiring immediate defecation to avoid incontinence) in anoreceptive individuals. In addition, they found an inverse relationship between the maximum resting sphincter pressure and the estimated number of acts of anal intercourse. Not surprisingly, they also found that the more traumatic forms of anoreceptive practices, such as brachioproctic intercourse (fisting), were more likely to result in objective sphincter dysfunction. Both the Chun and Miles studies used special equipment to measure the sphincter tone, and neither comments on whether sphincter laxity was apparent clinically in any of the subjects.

Interestingly, reflex anal dilatation (i.e., dilatation of the external and internal anal sphincters when the buttocks are gently separated for 30 s), which many authors have said is associated with anal intercourse, was not seen in any of the anoreceptive subjects in the Miles' study group [212].

Rectal Lacerations

Other, apparently rare, major complications that have been reported in adult males after penile–anal intercourse are nonperforating and, less frequently, perforating lacerations of the rectal mucosa [208, 209]. Mucosal lacerations are also seen in association with brachioproctic intercourse and the insertion of inanimate foreign bodies [208, 209]. On occasions, the injury may be fatal [208, 209]. Slaughter et al. [153] described five rectal lacerations among eight women who underwent proctoscopy after "anal contact" during a sexual assault. The relationship between the precise sexual act and the medical findings is not described.

Lubricants

Traces of lubricant found on vaginal or internal anal swabs may provide confirmatory evidence of recent penetration of a body orifice. This has particular relevance if a condom is worn during a penetrative act. Consequently, if the forensic practitioner has used lubricant (other than sterile water) on specula, proctoscopes, or gloved digits, it must be communicated to the forensic scientist. In terms of lubricant analysis, the most frequent request received by the FSS is to check vaginal swabs for the presence of condom lubricant. A review of cases at the Las Vegas Metropolitan

Police Department found that 19 of 80 complainants reported that either the assailant had worn a condom during the incident or they had experienced consensual intercourse with a partner wearing a condom within the 72 h preceding the assault (Cook YL, personal communication, 1993, and ref [213]). The most commonly encountered lubricants applied directly to the penis to aid penetration are Vaseline® (petroleum-based product) and KY® Jelly (water-based product) [214]. However, various other substances have been used to facilitate penetration during a sexual assault, including hand cream, cooking oil, and margarine, the diversity of the products apparently reflecting what is immediately at hand. Saliva is also used as a lubricant (see Sections "Skin" and "Cunnilingus and Anilingus") (Keating SM, personal communication, 1992). The constituents of condom lubricant (e.g., silicon and polyethylene glycol) are also found in numerous other skin care products and suppositories. Therefore, when relevant, the forensic practitioner should ask whether the complainant has applied anything to the genital/anal area in the preceding 2 days. This information should be noted on the paperwork that is made available to the forensic scientist so that scientist can source the relevant product to check what it contains. Dusting agents used on condoms may also be detected in the form of starch grains and lycopodium spores and can be used to correlate the finding of condom lubricant (Black R, personal communication, 2002). The same dusting agents are used on some clinical gloves. Therefore, the forensic practitioner should wear nonpowdered gloves when sampling the genital and anal area [215].

To maximize the possibility of lubricant detection, the necessary swabs should be obtained as soon as possible after the incident. If the doctor is aware that condom lubricants may be an issue, lubricant should not be used on the speculum or proctoscope during the examination. The forensic science laboratory must then be told that lubricant analysis may be relevant, because this potentially requires scientists from more than one discipline to examine the same sample, e.g., when both body fluids and lubricant analysis are requested. If the forensic science laboratory is not made aware of this requirement, potential evidence could be inadvertently destroyed during laboratory processes.

Many factors may affect the length of time that a lubricant will persist on skin or in a body orifice. Condom lubricant has been detected on a swab taken from an unwashed penis 50 h after intercourse and, in a different case, on a vaginal swab (also when the complainant had not washed or douched) taken 24 h after intercourse, but detection after such prolonged periods would appear to be exceptional (Black R, personal communication, 2002); water-based lubricants (e.g., those containing polyethylene glycol) have only been detected within 8 h of the sexual act [214, 216].

Blood and Urine Analysis

Reason for Analysis

When drugs or alcohol have been consumed or possibly administered before or during a sexual assault, consideration should be given to the need to obtain samples of blood and urine for toxicological analysis. The length of time that a drug or its metabolites remain detectable in blood or urine depends on several factors, including the quantity taken, the individual's metabolism, and the sensitivity and specificity of the analytical methods used by the laboratory [217]. Although the metabolites of some substances may be excreted for up to 168 h in the urine [217], many are detectable for only few hours (see Section "Persistence Data"). In general, drugs and their metabolites will be identifiable for longer in urine than in blood.

Method of Sampling

Blood

It is good practice to request a sample of blood for drug/alcohol analysis when the incident has occurred in the preceding 3 days. A single sample of 10 mL of venous blood should be placed in a container with an anticoagulant (e.g., potassium oxalate) and a preservative that prevents decomposition and fermentation (e.g., sodium fluoride) for drug and alcohol analysis. Wipes that contain alcohol should not be used to clean the skin before the blood sample is taken. If volatiles (e.g., amyl nitrate) are suspected, a portion of blood must be collected into a separate container.

Urine

It is good practice to request a sample of urine for drug/alcohol analysis when the incident has occurred in the preceding 3 days. If the allegation exceeds this time limit, contact the forensic science laboratory for advice on whether a sample is required. Ideally, 20 mL of urine should be placed in a container with a preservative that prevents decomposition and fermentation (e.g., sodium fluoride), although samples in plain bottles can be analyzed. Urine should be collected as soon as practically possible. Samples from complainants do not need to be witnessed. Complainants should be advised not to dispose of any towels, panty liners, or tampons at this stage.

Forensic Analysis

Forensic science laboratories have the capability of detecting a range of prescribed and illicit substances, but the persistence of different substances or their metabolites in the blood and urine of an individual depends on numerous factors. In some circumstances, the forensic science laboratory may undertake back calculations to estimate the blood alcohol concentration of the individual at the time of the sexual assault [218].

Table 3.1 Approximate detection windows for prescribed/illicit substances

Prescribed/abused drugs	Blood	Urine
Diazepam/temazepam	2 days	4 days
Methadone	1 day	2–3 days
Flunitrazepam	12–24 h	3 days
γ-Hydroxy butyrate	6 h	12 h
Barbiturates	1 or more days	2 or more days
Amphetamines	12–24 h	1–2 days
Ecstasy	12–24 h	2–3 days
Cocaine	12–24 h	2–3 days
Heroin/morphine	12–24 h	1–2 days
Cannabis	Occasional user 0–4 h	12 h
Cannabis	Regular user days weeks	

From personal communications with A. Clatworthy and J. Taylor, members of the toxicology section of the Metropolitan Laboratory of Forensic Science, 2003

Certain information is required to assist the forensic scientist with interpretation of the toxicological results.

- Sex, body weight, and build of the individual
- The time that any drugs/alcohol were consumed or believed to have been administered
- Was it a single dose or more?
- Did the complainant have an alcoholic drink between the incident and the medical examination?
- The exact time that the blood and urine samples were taken
- Details of any prescribed medication or other substances normally consumed by the individual, including quantity and the date and time of most recent use

Persistence Data

Table 3.1 provides the approximate detection windows for several prescribed/illicit substances. The detection windows depend on a few different factors, including the amount of substance used/administered and the frequency of use. Specialist advice is available for the toxicology section of the forensic laboratory.

Care of the Complainant

Medical Treatment

The medical facilities should be stocked with the necessary provisions to enable minor injuries to be cleaned and dressed. Some medications, e.g., analgesia, should be available.

Practical

The examination facilities should incorporate a shower for the complainant to use after the medical is complete, and a change of clothing should be available (preferably the patient's own garments). Complainants should have access to a telephone so that they can contact friends or relatives and should be encouraged to spend the next few days in the company of someone that they trust. On occasions, emergency alternative accommodation will need to be organized.

Pregnancy

Consideration must be given to the patient's risk of becoming pregnant. Whenever any risk is identified, the patient should be counseled regarding the availability of hormonal and intrauterine methods of emergency contraception; the most suitable method will depend on the patient profile and the time since the assault [219, 220]. When patients elect for insertion of an intrauterine contraceptive, they should be given prophylactic antibiotics (*see* Section "Sexually Transmitted Infections") either in advance of or at the time of the fitting. Follow-up appointments should be made at a convenient venue where pregnancy tests are available. Should the patient become pregnant because of the assault, she must be referred for sympathetic counseling. If the pregnancy is terminated, it may be relevant to seek permission from the patient for the products of conception to be retained for DNA analysis.

Sexually Transmitted Infections

Complainants of sexual assault are at risk of acquiring a sexually transmitted infection (STI) as a result of the assault [221, 222]. The need for STI prophylaxis and screening will depend on the nature and timing of the assault, and any information that is available regarding the assailant and the complainant's immunization status. This section is relevant to adult complainants. Appropriate national guidance regarding prophylaxis and screening in young persons and children should be accessed and followed [223].

Antibiotic prophylaxis for the prevalent, treatable organisms in the local population, e.g., *Chlamydia trachomatis* and *Neisseria gonorrhoeae*, should be considered at the initial presentation [224]. The use of antibiotic prophylaxis reduces the need for repeated examinations, avoids the anxiety incurred in waiting for the results, and is acceptable to the majority of complainants to whom it is offered [225]. Appropriate antibiotic regimens, with suitable alternatives for when the patient has allergies or is pregnant, should be devised in conjunction with the local genitourinary or microbiology clinics. Complainants who opt to take antibiotics should be advised to abstain from sexual intercourse until the course of antibiotics has been completed (or will be effective) and any regular sexual partners have been screened for STIs.

Some guidelines advocate STI screening for all adults at the time of presentation in recognition of the significant incidence of preexisting STI among women who allege rape and a high default rate for follow-up consultations [226, 227]. However, disclosure in court of preexisting STI can be detrimental to the complainant [59, 228]. Consequently, the first tests should be deferred until 10–14 days after the assault [224].

Acquisition of Hepatitis B virus (HBV) following nonconsensual sexual activity [229] has been described but, on the available data, appears to be uncommon. UK guidelines published in 2001 advise that HBV vaccine should be offered to all adult victims of sexual assault [222]. However, more recent guidelines question the evidence base for this recommendation and suggest that an individual risk assessment is used to inform the patient regarding his/her options [224].

It is not known how soon after the sexual assault the HBV vaccine needs to be given to have an effect. However, because of the long incubation period, an accelerated or super-accelerated course of the vaccine (0, 1, and 2 months or 0, 7, and 21 days, respectively) with a booster at 12 months may be efficacious if initiated within 3 weeks of the exposure [224].

Human immunodeficiency virus (HIV) can be acquired through sexual activity [230]. However, the risk is extremely low in areas of low prevalence. Therefore, forensic clinicians should undertake a risk assessment taking account of the prevalence of HIV in the area where the assault occurred, the timing and nature of the assault, and any HIV risk behaviors exhibited by the assailant [224, 231]. Animal studies suggest that the sooner HIV Post Exposure Prophylaxis (PEP) is given, the greater the chance of preventing seroconversion. Therefore, it is currently recommended that HIV PEP is commenced no more than 72 h after the assault [224, 231], and many sexual assault referral centers provide starter packs to ensure rapid access to the appropriate medicines. Patients considering HIV PEP should be advised of the unproven efficacy, potential side effects, and the fact that the long-term consequences are not fully understood [224]. If HIV PEP is given, baseline serological tests should be obtained for HIV. The recommended course of treatment lasts 4 weeks, and patients should be monitored by a genitourinary physician during this period.

Where relevant, complainants should be offered baseline serological tests for syphilis, HBV, hepatitis C, and HIV, which will be repeated at the relevant periods after assault. They should be advised to refrain from sexual intercourse, or use condoms meticulously, until adequate follow-up serological tests have been undertaken (minimum of 12 weeks) [224].

Psychological

Complainants of sexual assault must be offered immediate and ongoing counseling to help them cope with the recognized immediate and long-term psychological sequelae of a sexual assault [232]. Some examination facilities have 24-h access to trained counselors [233].

References

1. Association of Forensic Providers body fluid forum (BFF). A U.K. and Irish Forensic Biology working group. The objectives of the forum are to identify best practice in the recovery, identification and interpretation of body fluid evidence and to raise the profile of such evidence within forensic science, policing and legal arenas. The BFF is a subgroup of the Association for Forensic Science Providers and provides this Board with regular progress reports. For contact addresses see ref. (13) below
2. Royal College of Paediatrics and Child Health (2008) The physical signs of child sexual abuse – an evidence-based review and guidance for best practice. RCPCH, London
3. Adams JA, Kaplan RA, Starling SP, Mehta NH, Finkel MA, Botash AS, Kellog ND, Shapiro RA (2007) Guidelines for medical care of children who may have been sexually abused. J Pediatr Adolesc Gynecol 20:163–172
4. Adams JA (2008) Guidelines for medical care of children evaluated for suspected sexual abuse: an update for 2008. Curr Opin Obstet Gynecol 20:435–441
5. Department of Health, Home Office, Association of Chief Police Officers (2009) Revised National Service Guide – a resource for developing sexual assault referralcentres. DH, London. Available at Website: http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_107570. Accessed 14 Feb 2010
6. General Medical Council (1996) Intimate examinations. GMC, London
7. Faculty of Forensic and Legal (2008) Recommendations: consent from patients who may have been seriously assaulted. Available at Website: http://www.fflm.ac.uk. Accessed 2 Mar 2010
8. Hicks DJ (1980) Rape: sexual assault. Am J Obstet Gynecol 137:931–935
9. Evrard JR, Gold GM (1979) Epidemiology and management of sexual assault victims. Obstet Gynecol 53:381–387
10. Faculty of Forensic and Legal Medicine and Royal College of Paediatrics and Child Health (2010) Guidance for best practice for the management of intimate images that may become evidence in court 2010. Available at Website: http://www.fflm.ac.uk. Accessed 18 Feb 2010
11. Keating SM, Allard JE (1994) What's in a name? Medical samples and scientific evidence in sexual assaults. Med Sci Law 34:187–201
12. Benschop CCG, Wiebosch C, Kloostermam AD, Sijen T (2010) Post coital vaginal sampling with Nylon flocked swabs improves DNA typing. Forensic Sci Int Genet 4(2):115–121. doi: 10.1016/jfsigen.2009.07.003
13. Allard JE, Baird A, Davidson G, Jones S, Lewis J, McKenna L, Weston C, Scrimger D, Teppett G (2007) A comparison of methods used in the U.K. and Ireland for the extraction and detection of semen on swabs and cloth samples. Sci Justice 47:160–167
14. Keating SM (1988) The laboratory's approach to sexual assault cases. Part 1: sources of information and acts of intercourse. J Forensic Sci Soc 28:35–47
15. Clark MDB (1979) Metropolitan police laboratory examination kit for sexual offences. Police Surg 15:447–452
16. Forensic Science Service (2010) Technical update for forensic physicians on the use of lubricants 2006. Available at Website: http://www.fflm.ac.uk. Accessed 18 Feb 2010
17. Faculty of Forensic and Legal Medicine (2010) Recommendations on labelling of forensic samples 2009. Available at Website: http://www.fflm.ac.uk. Accessed 18 Feb 2010
18. Kafarowski E, Lyon AM, Sloan MM (1996) The retention and transfer of spermatozoa in clothing by machine washing. Can Soc Forensic Sci J 29:7–11
19. Jobin RM, DeGouffe M (2003) The persistence of seminal constituents on panties after laundering. Significance to investigations of sexual assault. Can Soc Forensic Sci J 36(1):1–10
20. Benecke M (1997) DNA typing in forensic medicine and in criminal investigations: a current survey. Naturwissenschaften 84:181–188
21. Mannucci A, Sullivan KM, Ivanov PL, Gill P (1994) Forensic application of a rapid and quantitative DNA sex test by amplification of the X–Y homologous gene amelogenin. Int J Leg Med 106:190–193

22. Foreman LA, Evett IW (2001) Statistical analyses to support forensic interpretation for a new ten-locus STR profiling system. Int J Leg Med 114:147–155
23. Gill P (2002) Role of short tandem repeat DNA in forensic casework in the UK – past, present and future perspectives. Biotechniques 32:366–372
24. Werrett DJ (1997) The national database. Forensic Sci Int 88:33–42
25. Hoyle R (1998) The FBI's national database. Biotechnology 16:987
26. Gill P, Sparkes B, Fereday L, Werrett DJ (2000) Report of the European Network of Forensic Science Institutes (ENFSI): formulation and testing of principles to evaluate STR multiplexes. Forensic Sci Int 108:1–29
27. Bar W, Brinkman B, Budowle B et al (1997) DNA recommendations. Further report of the DNA Commission of the ISFH regarding the use of short tandem repeat systems. International Society for Forensic Haemogenetics. Int J Leg Med 110:175–176
28. Olaisen B, Bar W, Brinkmann B et al (1998) DNA recommendations of the International Society for Forensic Genetics. Vox Sang 74:61–63
29. Leriche A et al (1998) Final report of the Interpol Working Party on DNA profiling. Proceedings from the 2nd Eurpoean Symposium on Human Idenitification. Promege Corporation, Innsbruck 1991, pp 48–54
30. Monckton DG, Jeffreys AJ (1993) DNA profiling. Curr Opin Biotechnol 4:660–664
31. Sinha SK, Budowle B, Arcot SS, Richley SL, Chakraborty R, Jones MD, Wojtkiewicz PW (2003) Development and validation of a multiplexed Y chromosome STR genotyping system Y-PLEX6, for forensic casework. J Forensic Sci 48:93–103
32. Bender K, Schneider PM, Ritter C (2000) Application of mtDNA sequenceanalysis in forensic case work for the identification of human remains. Forensic Sci Int 113:103–107
33. Hass C, Klesser B, Maake C, Bar W, Kratzer A (2009) mRNA profiling for body fluid identification by reverse transcriptase endpoint PCR and realtime PCR. Forensic Sci Int Genet 3(2):P80–P88
34. Bauer M, Kraus MD, Patzelt MD (1999) Detection of epithelial cells in dried bloodstains by reverse transciptase- polymerase chain reaction. J Forensic Sci 44(6):1232–1236
35. Rutty G (2001) An investigation into the transference and survivability of human DNA following simulated manual strangulation with consideration of the problem of third party contamination. Int J Leg Med 116:170–173
36. Graham EA, Rutty GN (2008) Investigation into normal background DNA on human necks. J Forensic Sci 53(5):1074–1082
37. Wickenheiser RA (2002) Trace DNA: a review, discussion of theory and applications of transfer of trace quantities of DNA through skin contact. J Forensic Sci 47:442–450
38. Lowe A, Murray C, Whitaker J, Tully G, Gill P (2002) The propensity of individuals to deposit DNA and secondary transfer of low level DNA from individuals to inert surfaces. Forensic Sci Int 129:25–34
39. Farmen RK, Jagho R, Cortez P, Froyland ES (2008) Assessment of individual shedder status and implications for secondary DNA transfer. For Sci Int Genet Suppl Ser 1:415–417
40. Phipps M, Petricevic S (2007) The tendency of individuals to transfer DNA to handled items. Forensic Sci Int 168:162–168
41. Sweet DJ (1995) Human bite marks – examination, recovery and analysis. In: Bowers CM, Bell GL (eds) Manual of forensic odontology. American Society of Forensic Odontology, Colorado
42. Clift A, Lamont CM (1974) Saliva in forensic odontology. J Forensic Sci Soc 14:241–245
43. Bowers CM, Bell GL (eds) (1995) Manual of forensic odontology. American Society of Forensic Odontology, Colorado
44. Sweet D, Lorente M, Lorente JA, Valenzuela A, Villanueva E (1997) An improved method to recover saliva from human skin: the double swab technique. J Forensic Sci Soc 42:320–322
45. Kenna J, Smyth M, McKenna L, Dockery C, McDermott S (2011) The recovery and persistence of salivery DNA on human skin. J Forensic Sci 56(1):170–175
46. Hall D, Fairley M (2004) A single approach to the recovery of DNA and firearm discharge residue evidence. Sci Justice 44(1):15–19

47. Girardin BW, Faugno DK, Seneski PC, Slaughter L, Whelan M (1997) Care of the sexually assaulted patient. In: Color atlas of sexual assault. Mosby, St. Louis, p 96
48. Lynnerup N, Hjalgrim H (1995) Routine use of ultraviolet light in medicolegal examinations to evaluate stains and skin trauma. Med Sci Law 35:165–168
49. Santucci K, Nelson D, Kemedy K, McQuillen K, Duffy S, Linakis J (1999) Wood's lamp utility in the identification of semen. Pediatrics 104:1342–1344
50. Jones DN (1963) The task of the Forensic Science Laboratory in the investigation of sexual offences. J Forensic Sci Soc 3:88–93
51. Stoilovic M (1991) Detection of semen and blood stains using Polilight® as a light source. Forensic Sci Int 51:289–296
52. Nelson DG, Santucci KA (2002) An alternative light source to detect semen. Acad Emerg Med 9:1045–1048
53. Casey D, Carroll C (2008) An evaluation of the blue *Crime – Lites* for semen detection. Glob Forensic Sci Today 6:26–30
54. Casey DG, Price J (2010) The sensitivity and specificity of the RSID saliva kit for the detection of human salivary amylase in the Forensic Science laboratory, Dublin, Ireland. Forensic Sci Int 194:67–71
55. Sweet D, Lorente JA, Valenzuela A, Lorente M, Villanueva E (1997) PCR-based DNA typing of saliva stains recovered from human skin. J Forensic Sci Soc 42:447–451
56. Cartwright PS (1986) Reported sexual assault in Nashville-Davidson County, Tennessee, 1980–1982. Am J Obstet Gynecol 154:1064–1068
57. Everett RB, Jimerson GK (1977) The rape victim: a review of 117 consecutive cases. Obstet Gynecol 50:88–90
58. Soules MR, Stewart SK, Brown KM, Pollard AA (1978) The spectrum of alleged rape. J Reprod Med 20:33–39
59. Kerr E, Cottee C, Chowdhury R, Jawad R, Welch J (2003) The Haven: a pilot referral centre in London for cases of serious sexual assault. Br J Obstet Gynaecol 110:267–271
60. Riggs N, Houry D, Long G, Markovchick V, Feldhaus K (2000) Analysis of 1,076 cases of sexual assault. Ann Emerg Med 35:358–362
61. Vale GL, Noguchi TT (1983) Anatomical distribution of human bite marks in a series of 67 cases. J Forensic Sci Soc 28:61–69
62. Wright R, West DJ (1981) Rape – a comparison of group offences and lone assaults. Med Sci Law 21:25–30
63. Muller C, Vogt S, Goerke R, Kordan A, Weinmann W (2000) Identification of selected psychopharmaceuticals and their metabolites in hair by LC/ESI-CID/MS and LC/MS/MS. Forensic Sci Int 113:415–421
64. Kintz P, Cirimele V, Jamey C, Ludes B (2003) Testing for GHB in hair by GC/MS/ MS after single exposure. Application to document sexual assault. J Forensic Sci 48:195–199
65. Negrusz A, Moore CM, Hinkel KB et al (2001) Deposition of 7-aminoflunitrazepam and flunitrazepam in hair after a single dose of Rohypnol®. J Forensic Sci 46:1–9
66. Guterman L (1998) Nailing the drug rapists. New Sci 160:4
67. Wicks J (2001) Managing Director Tricho-Tec Ltd. Paper presented at the Association of Police Surgeons Autumn Symposium. Northampton, UK, November
68. Ledray L (1993) Evidence collection: an update. J Sex Abuse 2:113–115
69. Young W, Bracken AC, Goddard MAA, Matheson S (1992) The New Hampshire sexual assault medical examination protocol project committee sexual assault: review of a national model protocol for forensic and medical evaluation. Obstet Gynecol 80:878–883
70. Salter MT, Cooke R (1996) The significance of transfer of fibres to head hair, their persistence and retrieval. Forensic Sci Int 1981:211–221
71. Exline DL, Smith FP, Drexler SG (1998) Frequency of pubic hair transfer during sexual intercourse. J Forensic Sci 43:505–508
72. Mann MJ (1990) Hair transfers in sexual assault: a six-year case study. J Forensic Sci Soc 35:951–955
73. Stone IC (1982) Hair and its probative value as evidence. Tex Bar J 45:275–279

74. Riis R (1990) Sexual assault combing evidence. Presented at the NWAFS Meeting. Jackson Hole
75. Higuchi R, Von Beroldingen CH, Sensabaugh GF, Erlich HA (1988) DNA typing from single hairs. Nature 332:543–546
76. Prahlow JA, Lantz PE, Cox-Jones K, Rao PN, Pettenati MJ (1996) Gender identification of human hair using fluoresence in situ hybridisation. J Forensic Sci 41:1035–1037
77. Cirimele V, Kinttz P, Staub C, Mangin P (1997) Testing of human hair of flunitrazepam and 7-amino-flunitrazepam by GC/MS-NCY. Forensic Sci Int 84:189–200
78. Ropero-Miller JD, Goldberger BA, Cone EJ, Joseph RE (2000) The deposition of cocaine and opiate analytes in hair and fingernails of humans following cocaine and codeine administration. J Anal Toxicol 24:496–508
79. Tsatsakis AM, Psillakis T, Paritsis N (2000) Phenytoin concentration in head hair sections: a method to evaluate the history of drug use. J Clin Psychopharmacol 20:560–573
80. Enos WF, Beyer JC (1981) The importance of examining skin and hair for semen in sexual assault cases. J Forensic Sci Soc 26:605–607
81. Henderson AR, Lai K, Power TEB, Samson OJ, Scott SE, Vintiner SK (2004) Prevalence of Foreign DNA Under Fingernails. Proceedings-challenges-and-changes-17th-International Symposium on the forensic sciences. Wellington
82. Malsom S, Flanagan N, McAlister C, Dixon L (2009) The prevalence of mixed DNA profiles in fingernail samples taken from couples who co-habit using autosomal and Y-STRs. Forensic Sci Int Genet 3(2):57–62
83. Cook O, Dixon L (2009) The prevalence of mixed DNA profiles in fingernail samples taken from individuals in the general population. Forensic Sci Int Genet 1(1):P62–P68
84. Thomas F, Baert H (1965) A new means of identification of the human being: the longitudinal striation of the nails. Med Sci Law 5:39–40
85. Lederer T, Betz P, Seidi S (2001) DNA analysis of fingernail debris using different multiplex systems: a case report. Int J Leg Med 114:263–266
86. Evans BA, Bond RA, Macrae KD (1988) Sexual behaviour in women attending a genitourinary medicine clinic. Genitourin Med 64:43–48
87. Keating SM, Higgs DF (1992) Oral sex – further information from sexual assault cases. J Forensic Sci Soc 32:327–331
88. Sexual Offences Act (2003) Home office. London, UK. Available at Website: http://www.opsi.gov. Accessed 2 Mar 2010
89. Criminal Justice (rape) (2010) Amendment Act (1990) No32/1990. Available at Website: http://www.acts.ie. Accessed 2 Mar 2010
90. Lind W, Carlson D (1995) Recovery of semen from chewing gum in an oral sexual assault. J Forensic Identification 45:280–282
91. Hampton HL (1995) Care of the woman who has been raped. N Engl J Med 332:234–237
92. Willott GM, Crosse MA (1986) The detection of spermatozoa in the mouth. J Forensic Sci Soc 26:125–128
93. Faculty of Forensic and Legal (2010) Recommendations for the collection of forensic specimens from complainants and suspects. January 2010. Available at Website: http://www.fflm.ac.uk. Accessed 2 Mar 2010
94. Allard JE (1997) The collection of data from findings in cases of sexual assault and the significance of spermatozoa on vaginal, anal and oral swabs. Sci Justice 37:99–108
95. Enos WF, Beyer JC (1978) Spermatozoa in the anal canal and rectum and in the oral cavity of female rape victims. J Forensic Sci Soc 23:231–233
96. Schlesinger SL, Borbotsina J, O'Neill L (1975) Petechial hemorrhages of the soft palate secondary to fellatio. Oral Surg 40:376–378
97. Giansanti JS, Cramer JR, Weathers DR (1975) Palatal erythema, another etiologic factor. Oral Surg 40:379–381
98. Damm DD, White DK, Brinker CM (1981) Variations of palatal erythema secondary to fellatio. Oral Surg 52:417–421

99. Girardin BW, Faugno DK, Seneski PC, Slaughter L, Whelan M (1997) Findings in sexual asault and consensual intercourse. In: Color atlas of sexual assault. Mosby, St. Louis, p 41
100. Bellizzi R, Krakow AM, Plack W (1980) Soft palate trauma associated with fellatio: case report. Mil Med 145:787–788
101. Girardin BW, Faugno DK, Seneski PC, Slaughter L, Whelan M (1997) Findings in sexual asault and consensual intercourse. In: Color atlas of sexual assault. Mosby, St. Louis, p 38
102. Johnson AM, Wadsworth J, Wellings K, Field J (1994) Heterosexual practices. In: Sexual attitudes and lifestyles. Blackwell Scientific Publications, Oxford, p 160
103. Bolling DR (1977) Prevalence, goals and complications of heterosexual anal intercourse in a gynecologic population. J Reprod Med 19:121–124
104. Keating SM (1988) Oral sex – a review of its prevalence and proof. J Forensic Sci Soc 28:341–355
105. Keating SM, Higgs DF (1994) The detection of amylase on swabs from sexual assault cases. J Forensic Sci Soc 34:89–93
106. Skerlavy M, Epstein JA, Sobrero AJ (1968) Cervical mucus amylase levels in normal menstrual cycles. Fertil Steril 19:726–730
107. Banaschak S, Moller K, Pfeiffer H (1998) Potential DNA mixtures introduced through kissing. Int J Leg Med 111:284–285
108. Mader CL (1981) Lingual frenulum ulcer resulting from orogenital sex. J Am Dent Assoc 103:888–890
109. Johnson AM, Wadsworth J, Wellings K, Field J (1994) Heterosexual practices. In: Sexual attitudes and lifestyles. Blackwell Scientific Publications, Oxford
110. Wellings K, Nanchahai K, Macdowall W (2001) Sexual behaviour in Britain: early heterosexual experience. Lancet 358:1843–1850
111. Jenny C, Kunhs ML, Fukiko A (1987) Presence of hymens in newborn female infants. Pediatrics 80:399–400
112. Heger A, Emans SJ, Muram D (eds) (2000) Evaluation of the sexually abused child. Oxford University Press, New York
113. Chadwick DL, Berkowitz CD, Kerns D, McCann J, Reinhart MA, Strickland S (1989) Color atlas of child sexual abuse. Year Book Medical Publishers, Chicago
114. Muram D (2000) Anatomic and physiological changes. In: Heger A, Emans SJ, Muram D (eds) Evaluation of the sexually abused child. Oxford University Press, New York, pp 105–107
115. Emans SJH, Goldstein DP (1990) The physiology of puberty. In: Pediatric and adolescent gynecology, 3rd edn. Little Brown, Boston, pp 95–97
116. Porkorny SF (1987) Configuration of the prepubertal hymen. Am J Obstet Gynecol 157:950–956
117. McCann J, Wells R, Simon M, Voris J (1990) Genital findings in prepubertal girls selected for nonabuse: a descriptive study. Pediatrics 86:428–439
118. Girardin BW, Faugno DK, Seneski PC, Slaughter L, Whelan M (1997) Care of the sexually assaulted patient. In: Color atlas of sexual assault. Mosby, St. Louis, pp 111–118
119. Masters WH, Johnson VE (1966) The vagina. In: The human sexual response. Little Brown, Boston, pp 69–70
120. Reade DJ (1986) Early scientific investigations of sexual assault. Police Surg 42–46
121. Eungprabhanth V (1974) Finding of the spermatozoa in the vagina related to elapsed time of coitus. Z Rechtamedizin 74:301–304
122. Davis A, Wilson E (1974) The persistence of seminal constituents in the human vagina. Forensic Sci 3:45–55
123. Florence A (1986) Du spermeet des taches de sperme en medecinelegale. Arch d'Anthropol Criminelled' Criminolo Psychol Normale Pathol 11:146–165
124. Laurell CB (1972) Electroimmunoassay. Scand J Clin Lab Invest 29:21
125. Graves HCB, Sensabaugh GF, Blake ET (1985) Postcoital detection of a male-specific semen protein: application to the investigation of rape. N Engl J Med 312:338–340
126. Desroches A, Buckle B, Fourney R (2009) Forensic biology evidence screening past and present. Can Soc Forensic Sci 42(2):101–120

127. Pang BCM, Cheung BKK (2007) Identification of human semenogelin in the membrane strip test as an alternative method for the detection of semen. Forensic Sci Int 169(1):27–31
128. Collins KA, Rao PN, Hayworth R et al (1994) Identification of sperm and non-sperm male cells in cervicovaginal smears using Fluoresecence In Situ Hybrid-isation – applications in alleged sexual assault cases. J Forensic Sci 39:1347–1355
129. Sibille I, Duverneuil C, Lorin de la Grandmaison G. Y–STR DNA amplification as biological evidence in sexually assaulted female victims with no cytological detection of spermatozoa. Forensic Sci Int 125:212–216
130. Rao PN, Collins KA, Geisinger KR et al (1995) Identification of male epithelial cells in routine post-coital cervicovaginal smears using Fluoresecence In Situ Hybridisation – application in sexual assault and molestation. Am J Clin Pathol 104:32–35
131. Divall GB (1985) Methods for the identification and menstrual blood. In: Lee HG, Gaensslen RE (eds) Advances in forensic science. Biomedical Publications, Foster City, pp 1–14
132. Allard J (1996) The facts of life. Contact FSS Intern Publication 24
133. Wilson EM (1982) A comparison of the persistence of seminal constituents in the human vagina and cervix. Police Surg 22:44–45
134. Keating SM (1988) The laboratory's approach to sexual assault cases. Part 2. Demonstration of the possible offender. J Forensic Sci Soc 28:99–110
135. Dziegelewski M, Simich JP, Rittenhouse-Olson K (2002) Use of a Y chromosome probe as an aid in the forensic proof of sexual assault. J Forensic Sci 47:601–604
136. Gaensslen RE (1983) Survival of spermatozoa in the vagina. In: Gaensslen RE (ed) Sourcebook in forensic serology, immunology and biochemistry. United States Government Printing Office, Washington, pp 144–152
137. Silverman EM, Silverman AG (1978) Persistence of spermatozoa in the lower genital tracts of women. JAMA 240:1875–1877
138. Rupp JC (1969) Sperm survival and prostatic acid phosphatase activity in victims of sexual assault. J Forensic Sci Soc 14:177–183
139. Paul DM (1984) Examination of the living. In: Mant AK (ed) Taylor's principles and practice of medical jurisprudence, 13th edn. Churchill Livingstone, Edinburgh, pp 64–105
140. Slaughter L, Brown CRV (1992) Colposcopy to establish physical findings in rape victims. Am J Obstet Gynecol 166:83–86
141. Cartwright PS, Moore RA, Anderson JR, Brown DH (1986) Genital injury and implied consent to alleged rape. J Reprod Med 31:1043–1044
142. Ramin SM, Satin AJ, Stone SC, Wendel GD (1992) Sexual assault in postmenopausal women. Obstet Gynecol 80:860–864
143. Anderson SL, Parker BJ, Bourguignon CM (2008) Changes in genital injury patterns over time in women after consensual intercourse. J Clin Forensic Med 15:306–311
144. Sommers MS, Zink TM, Fargo JD et al (2008) Forensic sexual assault examination and genital injury: is skin color a source of health disparity? Am J Emerg Med 26:857–866
145. Anderson S, McClain N, Riviello RJ (2006) Genital findings of women after consensual and non-consensual intercourse. J Forensic Nurs 2(2):59–65
146. Jones JS, Rossman L, Hartman M, Alexander CC (2003) Anogenital injuries in adolescemts after consensual sexual intercourse. Acad Emerg Med 10:1378–1383
147. Fraser IS, Lahteenmaki P, Elomaa K et al (1999) Variations in vaginal epithelial surface appearance determined by colposcopic inspection in healthy sexually active women. Hum Reprod 14:1974–1978
148. Norvell MK, Benrubi GI, Thompson RJ (1984) Investigations of microtrauma after sexual intercourse. J Reprod Med 29:269–271
149. Lauber AA, Souma ML (1982) Use of toluidine blue for documentation of traumatic intercourse. Obstet Gynecol 60:644–648
150. McCauley J, Gorman RL, Guzinski G (1986) Toluidine blue in the detection of perineal lacerations in pediatric and adolescent sexual abuse victims. Pediatrics 78:1039–1043
151. McCauley J, Guzinski G, Welch R, Gorman R, Osmers F (1987) Toluidine blue in the corroboration of rape in adult victim. Am J Emerg Med 5:105–108

152. Whitley N (1978) The first coital experience of one hundred women. JOGN 41–54
153. Slaughter L, Brown CRV, Crowley S, Peck R (1997) Patterns of genital injury in female sexual assault victims. Am J Obstet Gynecol 176:609–616
154. Adams JA, Girardin B, Faugno D (2001) Adolescent sexual assault: documentation of acute injuries using photo-colposcopy. J Pediatr Adolesc Gynecol 14:175–180
155. Wilson KFG (1966) Lower genital tract trauma. Aust N Z J Obstet Gynaecol 6:291–293
156. Ahmed E, Syed SA, Parveen N (2006) Female consensual coital injuires. JCPSP 16(5):333–335
157. McCann J, Miyamoto S, Boyle C, Rogers K (2007) Healing of non-hymenal genital injuries in pre-pubertal and adolescent girls: a descriptive study. J Pediatr 120:1000–1011
158. Kellogg ND, Parra JM (1991) Linea vestibularis: a previously undescribed normal genital structure in female neonates. Pediatrics 87:926–929
159. Ferrell J (1995) Sexual assault: clinical issues, Foley catheter balloon technique for visualizing the hymen in female adolescent sexual abuse victims. J Emerg Nurs 21:585–586
160. McCann J, Miyamoto S, Boyle C, Rogers K (2007) Healing of hymenal genital injuries in pre-pubertal and adolescent girls: a descriptive study. J Pediatr 119:e1094–e1106
161. White C, McLean I (2006) Adolescent complainants of sexual assault; injury patterns in virgin and non-virgin groups. J Clin Forensic Med 13:172–180
162. Teixera W (1981) Hymenal colposcopic examination in sexual offences. Am J Forensic Med Pathol 2(3):209–215
163. Kellogg ND, Menard SW, Santos A (2004) Genital anatomy in pregnant adolescents: "normal" does not mean "nothing happened". Pediatrics 113(1):e67–e69
164. Goodyear-Smith FA, Laidlaw TM (1998) What is an "intact hymen"? A critique of the literature. Med Sci Law 38:289–301
165. Emans SJ, Woods E, Allred E, Grace E (1994) Hymenal findings in adolescent women, impact of tampon use and consensual sexual activity. Pediatrics 125:153–160
166. Underhill R, Dewhurst J (1978) The doctor cannot always tell: medical examination of the 'intact' hymen. Lancet 1:375–376
167. Wilson F, Swartz DP (1972) Coital injuries of the vagina. Obstet Gynecol 39:182–184
168. Fish SA (1956) Vaginal injury due to coitus. Am J Obstet Gynecol 72:544–548
169. Metsala P, Nieminen U (1968) Traumatic lesions of the vagina. Acta Obstet Gynecol Scand 47:483–488
170. Gray MJ, Norton P, Treadwell K (1981) Tampon-induced injuries. Obstet Gynecol 58:667–668
171. Bowyer L, Dalton ME (1997) Female victims of rape and their genital injuries. Br J Obstet Gynecol 104:617–620
172. Manser T (1991) Findings in medical examinations of victims and offenders in cases of serious sexual offences – a survey. Police Surg 38:4–27
173. Burgess AW, Holmstrom LL (1973) The rape victim in the emergency ward. Am J Nurs 73:1741–1745
174. Slaughter L, Brown CRV (1991) Cervical findings in rape victims. Am J Obstet Gynecol 164:528–529
175. Hakanson EY (1966) Trauma to the female genitalia. Lancet 86:286–291
176. Masters WH, Johnson VE (1966) The penis. In: The human sexual response. Little Brown, Boston, pp 171–203
177. Muram D (1992) Anatomy. In: Hegar A, Emans SJ (eds) Evaluation of the sexually abused child. Oxford University Press, New York, p 73
178. Girardin BW, Faugno DK, Seneski PC, Slaughter L, Whelan M (1997) Anatomy and the human sexual response. In: Color atlas of sexual assault. Mosby, St. Louis, p 11
179. Ansell R (2002) Secondary transfer of seminal constituents. Can Soc Forensic Sci J 35(1):23–27
180. Hass C, Klesser B, Maake C, Bar W, Kratzer A (2009) mRNA profiling for body fluid identification by reverse transcriptase endpoint PCR and realtime PCR. Forensic Sci Int Genet 3(2):80–88
181. Cina SJ, Collins KA, Pettenati MJ, Fitts M (2000) Isolation and identification of female DNA on post-coital penile swabs. Am J Forensic Med Pathol 21:97–100

182. Farah R, Cerny JC (1973) Penis tourniquet syndrome and penile amputation. Urology 11:310–311
183. Garty BZ, Mimouni M, Varsano I (1983) Penile tourniquet sydrome. Cutis 31:431–432
184. Kerry RL, Chapman DD (1973) Strangulation of appendages by hair and thread. Pediatr Surg 8:23–27
185. Wheatley JK (1983) Genital injury during intercourse. Med Aspects Hum Sex 17:24A–24J
186. Ball TP, Pickett JD (1975) Traumatic lymphangitis of penis. Urology IV:594–597
187. Davies DM, Mitchell I (1978) Fracture of the penis. Br J Urol 50:426
187a. Pryor JP, Hill JT, Packham DA, Yates-Bell AJ (1981) Penile injuries with particular reference to injury to the erectile tissue. Br J Urol 53:42–46
188. Paul DM (1977) The medical examination of the live rape victim and the accused. Leg Med Annu 139–153
189. Wells DL (1996) Genital trauma amongst young boys. J Clin Forensic Med 3:129–132
190. Hobbs CJ, Wynne JM (1996) Physical signs of child abuse. WB Saunders, Philadelphia
191. Johnson AM, Wadsworth J, Wellings K, Field J (1994) Heterosexual practices. In: Sexual attitudes and lifestyles. Blackwell Scientific Publications, Oxford, p 163
192. Johnson AM, Wadsworth J, Wellings K, Field J (1994) Sexual diversity and homosexual behaviour. In: Sexual attitudes and lifestyles. Blackwell Scientific Publications, Oxford, pp 183–223
193. Bang L (1993) Rape victims – assaults, injuries and treatment at a medical rape trauma service at Oslo Emergency Hospital. Scand J Prim Health Care 11:15–20
194. Hillman RJ, O'Mara N, Taylor-Robinson D, Williams Harris JR (1990) Medical and social aspects of sexual assault of males: a survey of 100 victims. Br J Gen Pract 40:502–504
195. Hillman R, O'Mara N, Tomlinson D, William Harris JR (1991) Adult male victims of sexual assault: an underdiagnosed condition. Int J STD AIDS 2:22–24
196. Girardin BW, Faugno DK, Seneski PC, Slaughter L, Whelan M (1997) Anatomy and the human sexual response. In: Color atlas of sexual assault. Mosby, St. Louis, pp 14–16
197. Fenger C (1997) Anal canal. In: Sternberg SS (ed) Histology for pathologists, 2nd edn. Lippincott-Raven, Philadelphia, pp 551–571
198. Nivatovongs S, Stern HS, Fryd DS (1981) The length of the anal canal. Dis Colon Rectum 24:600–611
199. Goligher J Duthie HL, Nixon HH (1984) Surgical anatomy and physiology of the anus, rectum and colon. In: Surgery of the anus, rectum and colon, 5th edn. BaillièreTindall, London, p 15
200. Parks AG, Porter NH, Melzak J (1962) Experimental study of the reflex mechanism controlling the muscles of the pelvic floor. Dis Colon Rectum 5:401–414
201. Davies A (1979) Discussion of spermatozoa in the anal canal and rectum and in the oral cavity of female rape victims. J Forensic Sci Soc 24:541–542
202. Willott GM, Allard JE (1982) Spermatozoa – their persistence after sexual intercourse. Forensic Sci Int 19:135–154
203. Bush RA, Owen WF (1986) Trauma and other noninfectious problems in homosexual men. Med Clin North Am 70:549–566
204. Hilden M, Berit S, Sidenius K (2005) Genitoanal injury in adult female victims of sexual assault. Forensic Sci Int 154:200–205
205. Maguire W, Goodall E, Moore T (2009) Injury in adult female sexual assault complainants and related factors. Eur J Obstet Gynaecol Reprod Biol 142:149–153
206. Goligher J, Duthie HL, Nixon HH (1984) Anal fissure. In: Surgery of the anus, rectum and colon, 5th edn. Baillière Tindall, London, p 150
207. Keighley MRB, Williams NS (1993) Fissure in ano. In: Surgery of the anus, rectum and colon. Saunders, Philadelphia, pp 364–386
208. Crass RA, Tranbaugh RF, Kudsk KA, Trunkey DD (1981) Colorectal foreign bodies and perforation. Am J Surg 142:85–88
209. Barone JE, Yee J, Nealon TF (1983) Management of foreign bodies and trauma of the rectum. Surg Gynecol Obstet 56:453–457

210. Rakotomalala L, de Parades V, Parisot C, Atienza P (1996) Ruptures multiples du sphincter interne après viol anal: une cause peuconnued'incontinenceanale. Gastroentérol Clin Biol 20:1142–1143
211. Chun AB, Rose S, Mitrani C, Silvestre AJ, Wald A (1997) Anal sphincter structure and function in homosexual males engaging in anoreceptive intercourse. Am J Gastroenterol 92:465–468
212. Miles AJG, Allen-Mersh TG, Wastell C (1993) Effect of anoreceptive intercourse on anorectal function. J R Soc Med 86:144–147
213. Blackledge RD (1996) Condom trace evidence: a new factor in sexual assault investigations. FBI Law Enforcement Bull 12–16
214. Greaves C (1998) Safe sex? Is it so safe? Contact FSS Intern Publication 25:20–21
215. McCrone WC, Delly JG (1973) The particles atlas. 3:600; 702
216. Blackledge RD, Vincenti M (1994) Identification of polydimethylsiloxane lubricant traces from latex condoms in cases of sexual assault. J Forensic Sci Soc 34:245–256
217. Jansen K (1998) Date rape drugs. Bull Int Assoc Forensic Toxicol 28:18–20
218. Ferner RE (1996) Ethanol. In: Forensic pharmacology. Oxford University Press, Oxford, pp 122–124
219. Faculty of Family Planning and Reproductive Health Care Clinical Effectiveness Unit (2010) Emergency contraception. Available at Website: http://www.fsrh.org. Accessed 12 Feb 2010
220. Faculty of Sexual and Reproductive Health Care Clinical Effectiveness Unit (2010) New product Review Ulipristal (ellaOne®).Faculty Statement fromt the Clinical effectiveness Unit. Available at Website: http://www.fsrh.org. Accessed 12 Feb 2010
221. Jenny C, Hooton TM, Bowers A et al (1990) Sexually transmitted diseases in victims of rape. N Engl J Med 322:713–716
222. Estreich S, Forster GE, Robinson A (1990) Sexually transmitted diseases in rape victims. Genitourin Med 66:433–438
223. British Association for Sexual Health and HIV (2009) United Kingdom National guidelines on the management of sexually transmitted infections and related conditions in children and young people. Available at Website: http://www.bashh.org. Accessed 14 Feb 2010
224. Home Office (2010) Medical care following sexual assault – guidelines for sexual assault referral centres. Available at Website: http://www.police.homeoffice.gov.uk.org. Accessed 14 Feb 2010
225. Gibb AM, McManus T, Forster GE (2003) Should we offer antibiotic prophylaxis post sexual assault? Int J STD AIDS 14:99–102
226. British Association for Sexual Health and HIV (2001) National guidelines on the management of adult victims if sexual assault. Available at Website: (http://www.bashh.org). Accessed 14 Feb 2010
227. Ross JDC, Scott GR, Busuttil A (1991) Rape and sexually transmitted diseases: patterns of referral and incidence in a department of genitourinary medicine. J R Soc Med 84:657–659
228. Lacey HB (1991) Rape, the law and medical practitioners. Br J Sex Med 89–92
229. Crowe C, Forster GE, Dinsmore WW, Maw RD (1996) A case of acute hepatitis B occurring four months after multiple rape. Int J STD AIDS 7:133–134
230. Limb S, Kawsar M, Forster GE (2002) HIV post-exposure prophylaxis after sexual assault: the experience of a sexual assault service in London. Int J STD AIDS 13:602–605
231. British Association for Sexual Health and HIV (2006) United Kingdom guideline for the use of post-exposure prophylaxis for HIV following sexual exposure. Available at Website: http://www.bashh.org. Accessed 14 Feb 2010
232. Burgess AW, Holmstrom LL (1974) Rape trauma syndrome. Am J Psychiatry 131:981–986
233. Duddle M (1991) Emotional sequelae of sexual assault. J R Soc Med 84:26–28

Chapter 4
Injury Assessment, Documentation, and Interpretation

Jason J. Payne-James and Judith Hinchliffe

Introduction

Assessing, documenting, and interpreting injuries or scars which have been sustained as a result of trauma or violence is one of the key roles of any forensic physician or forensic pathologist. Crimes of violence – for example inter-personal, part of armed conflict, or accident, or terrorism, occur globally. Although crime in general is decreasing in the UK, the incidence of serious violent crime is stable and some (such as sexual assault) is increasing in incidence [1]. Nonjudicial assault (such as torture) has also become more widely recognized and documented [2]. This chapter addresses the issues of physical assault and the assessment and documentation of wounds, scars, or injury. It has been suggested that the definition of physical injury in the forensic medical context should be "damage to any part of the body due to the deliberate or accidental application of mechanical or other traumatic agent" [3]. The latter term would include agents such as heat or cold.

The purpose of assessment and documentation is, as far as possible, to assist in establishing how the recorded mark, abnormality, or scar is caused – which may often be at issue in courts or tribunals of law. In addition, the forensic physician's role may be to assist in determining the relevance of an absence of visible injury. The skills of assessment and documentation are ones that should be within the remit of any doctor (and within the remit of appropriately trained alternate healthcare professionals). Unfortunately, this is rarely done fully and appropriately, partly due to the

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immediate necessity of therapeutic intervention, but also in part due to absence of training. The interpretation of the causes of wounds, scars, and injuries is best undertaken by those with forensic expertise, as there may be many factors involved in such interpretation [4] That interpretation still requires best quality evidence, which may include ambulance records, hospital records, operative notes, and photographic images. As interpretation of wounds, scars, and injuries may often be undertaken by review of documents without examination of the patient – for example, written descriptions, body chart mapping, or photographs – it is imperative that the descriptions given are comprehensible to all. For example, the term "wound" has specific meaning in certain jurisdictions, relating to whether the skin or mucosa is completely breached. It is more appropriate for those documenting injuries to ensure that they have documented them in detail and unambiguously so that the courts can then make the decision as to the most appropriate legal interpretation of the injury or injuries described and their relevance to the case, as this may have significant relevance to the type of charge made against an individual and the punishment if found guilty.

In many cases the initial examination and assessment may have been undertaken for purely therapeutic purposes, and the forensic significance of the injuries may not become apparent until many weeks or months later. Scrutiny of the doctor's notes at a later stage, possibly in court, may reveal serious deficiencies, which not only undermine the credibility of the individual practitioner, but can also seriously prejudice the legal proceedings. Pediatricians, primary care physicians, and emergency medicine specialists are examples of those "nonforensic" practitioners who may encounter patients with injuries that may be contentious within court proceedings.

Assessment and Documentation

The key to all assessments is reliance on the basic tenets of medical practice which are the taking of an appropriate history and undertaking an appropriate physical examination. The findings of the history and examination must be recorded contemporaneously, clearly, and unambiguously. If a case goes to court, all such documentation (e.g., contemporaneous medical notes – handwritten or computerized – including body charts) may be reviewed critically by other doctors, legal advisors, and the courts. Consent for the examination and for subsequent production of a medical report must be sought from the individual being examined. It should also be borne in mind that false, vexatious, or frivolous accusations of assault are made, and the examiner should be aware that false allegations and counterallegations do occur which may only become obvious at a later date.

Key Factors

Table 4.1 identifies a number of key factors which may have relevance in the examination of anyone with injuries and which should be considered when the history is taken from the injured person.

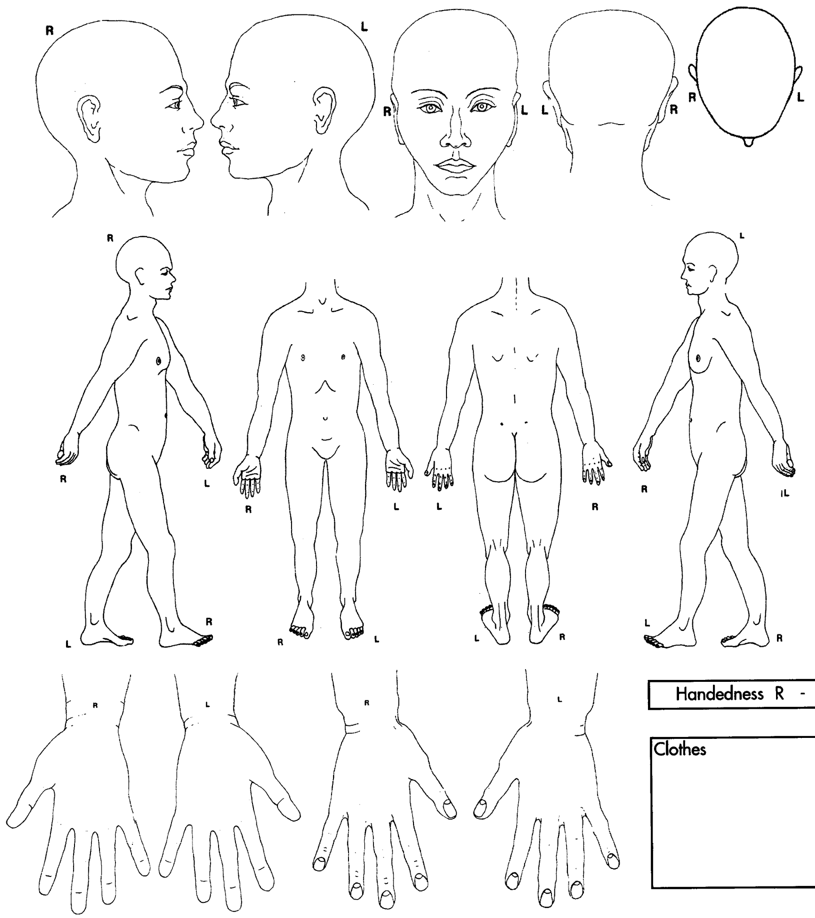
Table 4.1 Examples of factors which may be relevant to determine from history

How was the injury sustained?
Weapon or weapons used (is it still available?)
What time was the injury sustained?
Has injury been treated?
Preexisting illnesses (e.g., skin disease)
Regular physical activity (e.g., contact sports)
Regular medication (e.g., anticoagulants, steroids)
Handedness of victim and suspect
Use of drugs and alcohol
Clothing worn

It is important to document the time at which the injury was said to have occurred. Injuries heal and thus the appearance of an injury following assault is time-dependent. Assaults may not be reported for days or weeks afterwards. In some cases, the only evidence may be fully healed and mature scars. There may be a number of injuries from different incidents at different times. Specific times should be sought for each. If more than one type of assault has occurred, clear records must be made of which injury was accounted for by which implement. Document the handedness (left or right or ambidextrous) of both victim and assailant if known, as this may affect the interpretation of injury causation. Widely diverging accounts may be given by different witnesses – it is not the forensic physician's role to determine which account is necessarily the correct one, but to use medical knowledge applied to the evidence presented to assist the court in determining the true account. In many cases, the medical interpretation is neutral. These accounts may also be influenced by the effect of drugs and/or alcohol and it is appropriate to assess the influence that these may have in each case. Knowledge of the type of weapon used can be very important when assessing injury as particular implements can give identifiable injuries. The type of clothing worn (e.g., long sleeved shirts, leather jackets, armless vests) should be noted. When examining any individual for injury, all these features should at least be considered to see whether they may have relevance to the case (e.g., the amount of force for a knife to have penetrated the skin) – others may become relevant as the examination progresses or as other accounts of any assault are given, or additional forensic evidence becomes available at a later date.

Documentation of injuries can be in a variety of formats, including hand-drawn notes, annotated proforma body diagrams, and photographic. If photographic images are supplied, it is absolutely essential that the quality of the images adds to, rather than detracts from, the evidence [5]. Figure 4.1 illustrates one form of body chart and note system. Table 4.2 lists the characteristics of each injury that may be needed for appropriate documentation.

Digital photographic images have now become a common way of documenting injury, but the digital image evidence should only assist the evidence from contemporaneous written and hand-drawn notes. Caution should be exercised if photographic images are used as a sole source of medical evidence. Ensure at the time of



Handedness R - L

Clothes

No other injuries observed or complained of ☐ Time of injury ☐ Time of photographs ☐

Samples taken:

.../1-	at	h	.../4-	at	h	.../7-	at	h
.../2-	at	h	.../5-	at	h	.../8-	at	h
.../3-	at	h	.../6-	at	h	.../9-	at	h

Additional samples:...

Given to..**at**..................**h**

I consent* to a full examination and/or taking of samples and/or taking of photographs for educational purposes including publication in scientific & medical journals, books and all other media including electronic and am aware that formal reports/statements may be prepared from these notes for police, court and other purposes, and I consent to such reports/statements being made:

*** delete as appropriate**

Name .... Witness *(name and signature)*

Signed ....

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Fig. 4.1 Body chart and note system

Table 4.2 Potential relevant information required when assessing injury

Location (anatomical – measure distance from landmarks)
Pain
Tenderness
Stiffness
Type (e.g., bruise, cut, abrasion)
Size (use metric values)
Shape
Color
Orientation
Age
Causation
Handedness
Time
Transientness (of injury)

examination that each injury is accounted for by the account given. If an injury appears not to be consistent with the account given, question it at the time. In many cases individuals who have been involved in fights or violent incidents are simply unaware of the causation of many sites of injury. Reexamination of injuries or sites of injury 24–48 h after initial assessment is of use to see how injuries evolve and whether bruises have appeared or other sites of injury noted. Pre- and posttreatment examination and photography is often very useful. Photographs, should always be undertaken with rules & colour has to allow proper comparison at a later date. A combined rule & color chart is available at www.forensigraph.co.uk.

Types of Injury

Anyone involved in assessment of injury for court must understand the range of terms that can be applied to different injury. Every doctor should have a consistent system of his/her own that ensures that the nature of each injury is described clearly, reproducibly, and unambiguously in note form – utilizing accepted terms of classification. The confusing assortment of terms used by doctors and other healthcare professionals workers often results in problems in court. For example, the inappropriate or inaccurate description use of the term "laceration" to describe a cut can, if applied incorrectly, potentially alter the causation of a wound from one caused by a sharp instruments such as a knife, to a blunt impact such as a punch, – which may have substantial impact on the judicial outcome [6]. For medicolegal purposes, a standard nomenclature must be adopted when describing injuries. The following classification is one that is appropriate and clear. Most visible injuries will fall into one of the groups shown in Table 4.3. These injury types are expanded on below.

Inflicted injury (whether deliberate or accidental) may be divided into two main types – blunt impact (or blunt force or blunt contact injury) and sharp implement

Table 4.3 Classification of injuries

Wheals and erythema (reddening)
Bruises (contusion, ecchymosis)
Hematoma
Petechiae
Abrasions (grazes)
Scratches
Scuff/brush abrasions
Point abrasion
Lacerations
Incisions
Slash
Chop
Stab wounds
Firearms
Bites

injury. Blunt injury describes injury not caused by instruments or objects with cutting edges. Blunt force injury can be caused in many, both direct (e.g., punch or kick) and indirect (e.g., by traction, torsion, and shear stresses) [7,8]. Injury is caused dynamically, with possible movement of the body towards, away from, or with the impacting object. Examples of objects that can cause blunt impact injuries include fists, feet, baseball bat, and police baton. A blunt force blow can cause a range of symptoms or signs and the resultant injuries are dependent on a number of factors including force, location, and impacting surface, which range from no visible evidence of injury, to tenderness (pain on pressure at the site of contact), or pain at the site of contacts, reddening, swelling, bruising, abrasions, lacerations, and broken bones. Each type of injury may be present alone or in combination. Such injuries are seen at the point of contact of impacting object on the body. Bruises may migrate away from the point of contact by gravity after a period of time. Abrasions give a clear indication of the actual site of impact, bruises do not necessarily. Patterns of injury may indicate whether a particular impacting object was involved (e.g., a police baton with a distinctive tip outline), or a cluster of injuries may indicate a mechanism (e.g., a hand grip). Blunt impact injuries can be described (in terms of force applied) as being weak, weak/moderate, moderate, moderate/severe, severe. An example of a weak force might be a light slap to the face, where no pain is sustained at impact; an example of a severe force might be a punch directed towards the face with as much effort as possible.

Sharp injuries are those caused by any implement with cutting edges (e.g., knives, scissors, glass, razor blades). The injuries may be of varied types including incised – where the cutting edge runs tangentially to the skin surface cutting through skin and deeper anatomical structures – or stab – where the sharp edge penetrates the skin into deeper structures. An incised wound is generally longer than it is deep, whereas a stab wound is deeper than it is wide. Forces required to cause sharp injuries and the effect of such injuries are variable as a very sharp pointed object may penetrate vital structures with minimal force. Generally, the skin offers most resistance to penetration (with the exception of bone and cartilage). Other cutting injuries included slash or chop type injuries from weapons such as machetes or Samurai swords or axes, and the injuries seen may (dependent on the nature of the implement) have a mixture if both blunt and sharp force features [9–12].

Many blunt contact injuries may cause initial pain and discomfort – which resolve within a few minutes, and tenderness – which may still be elicited hours or days later – with no visible sign of injury. Absence of visible injury does not imply that no assault or injury has taken place.

Wheals and erythema (reddening) are also nonpermanent evidence of trauma caused by initial vasodilatation and local release of vasoactive peptides following an injury such as a slap, scratch, or punch – which will leave no mark after a few hours. The classic features of the triple reaction are present, but no specific damage is done to any tissues. Thus, an initial reddening associated with pain with possible subsequent development of local swelling may be present initially – but after a few hours has completely resolved, unlike bruising which will still be present after 24 h or more. Reddening caused by vasodilation can be distinguished from bruising by applying finger pressure – bruises do not blanch on finger pressure.

Size and Shape of the Injury

Size of an injury should always be recorded (and if photographed should have a rule & colour chart (www.forensigraph.com) in view). It should be ascertained using a ruler or a pair of calipers and recorded in centimeters or millimeters. Since measurements given in imperial units may be easier for a jury to understand, it is also acceptable to include the equivalent size of an injury in inches. The shape of the wound should also be noted; simple terms such as circular, triangular, V-shaped, or crescentic are useful, but if the wound shape is irregular or complex then it is possibly easier to record this feature on a body chart. Wounds also may have depth, but it is rarely possible to determine wound depth accurately (or often, at all) in the living which makes interpretation difficult. Ideally, all surgeons operating on penetrating wound injuries should be asked to record direction and depth of penetration.

Position of the Injury

Location of an injury is best done by relating it to fixed anatomic landmarks. On the head, one can use the eyes, ears, nose, and mouth, on the neck the prominence of the thyroid cartilage and the sternocleidomastoid muscles, and on the trunk the nipples, umbilicus, and bony prominences can be used as points of reference. The advantages of using simple anatomic diagrams and body charts for locating the injury are self-evident. It is a simple process to record the position of an injury accurately, yet when medical records are reviewed it is common to find little or no indication of precise site of injury.

Aging Injuries

Identifying a specific time or time frame to the infliction of an injury is one of the most frequently asked and possibly least frequently satisfactorily answered questions in forensic practice. However, injuries inflicted shortly before examination (in both living and deceased) will show no clinical or pathological evidence of healing. The physiological healing process (whether of blunt or sharp force injury) depends on a number of variables including the site of injury, the force applied, the severity of tissue damage, infection, and previous treatment. These can all make assessment of the age of a wound difficult. Bruises often become more prominent some hours or even days after infliction because of diffusion of blood closer to the skin surface; on occasion, a recent deep bruise may be mistaken for an older, more superficial lesion. Bruises resolve over a variable period ranging from days to weeks; the larger the bruise the longer it will take to disappear. The colors of a bruise can include (dependent on the examiner) blue, mauve, purple, brown, green, and yellow – and all tints and hues associated with these. Many bruises exhibit multiple colors. The key study which looked prospectively at bruise evolution by color showed that a bruise with a yellow color was more than 18 h old and that the colors red, blue, and purple/black could occur anytime within 1 h of bruising to resolution (up to 21 days in the study) [13]. This would indicate that coloration of bruises and the progress and change of color patterns cannot (with the exception of a yellow bruise which may be considered to be more than 18 h old) be used to time the injury. However, it should also be recognized that additional factors (due to color reproduction and color perception) render even the 18 h evidence questionable. Studies show that estimation of bruise age from color photographs is also imprecise and should not be relied upon – as the color values are not accurate [14]. This was supported by another study [15] which identified great interobserver variability in color matching both in vivo and in photographic reproductions. Other information (e.g., a witnessed blow) is the only way of reliably timing a bruise. Recent work suggests that in children, no evidential value for aging of bruises should be put on color [16].

Abrasions sustained during life are usually red–brown in color and exude serum and blood, which harden to form a scab. This scab organizes over a few days, before detaching to leave a pink, often intact surface. This process may be modified by accidental knocking of scabs, or picking or scratching at the scab site.

In the absence of medical intervention, lacerations tend to heal with scarring, usually over a period of days or weeks, whereas incisions, the edges of which are often apposed, heal within a few days although some may scar badly.

Transient Lesions

Swelling, redness, and tenderness, although frequently caused by trauma, are not specific signs of injury. Although it is important to record whether these features are present, it must be borne in mind that there may also be nontraumatic causes for these lesions (e.g., eczema/dermatitis, impetigo). Red marks outlining an apparent injury, for example, the imprint of a hand on the slapped face or buttock of a child, should be photographed immediately as such images may fade within an hour or so and leave no residual marks.

Types of Injury

Bruises

Bruising is visible evidence of leakage of blood into soft tissues as a result of injury to blood vessels. Ecchymosis and contusion have been used variously to describe different sizes of injury, but do not enhance understanding of either causation or mechanism of injury and should no longer be used – although contusion is sometimes useful to simply describe blood leakage from damaged blood vessels in internal organs such as the brain. Hematoma should be used to refer to a collection of blood forming a fluctuant mass under the skin. The difference between that and a standard "bruise" is that a hematoma may be capable of being aspirated by needle – in the same way as a collection of pus. Bruising is caused when an impact damages blood vessels such that blood leaks into the perivascular tissues and is evident on the skin surface as discoloration. Such discoloration changes in color, shape, and location as the blood pigment is broken down and resorbed. In some cases, although blood vessels may be damaged, there may be no visible evidence on the skin. In certain cases, it may take hours or days for any bruise to become apparent (as the blood diffuses through damaged tissue). The blunt force ruptures small blood vessels beneath the intact skin, and blood then escapes to infiltrate the surrounding subcutaneous tissues under the pumping action of the heart (Fig. 4.2). Thus, theoretically at least, bruising is not produced after death. In fact, severe blows inflicted after death may cause some degree of bruising, although this is usually only slight. Bruises may be associated with other visible evidence of injury such as abrasions and lacerations, and these lesions may obscure the underlying bruise.

Bruises vary in severity according to the site and nature of the tissue struck, even when the force of the impact is the same. For example, a moderate blow may produce bruising associated with soft tissue swelling – for example a black eye. There are, however, other causes for black eyes, including a direct blow to the forehead (even with no direct impact to the eye region itself) with blood from damaged scalp draining down over the supraorbital ridge or a fracture of the base of the skull allowing blood to traverse the orbital roof manifesting itself as a black eye (see Fig. 4.3).

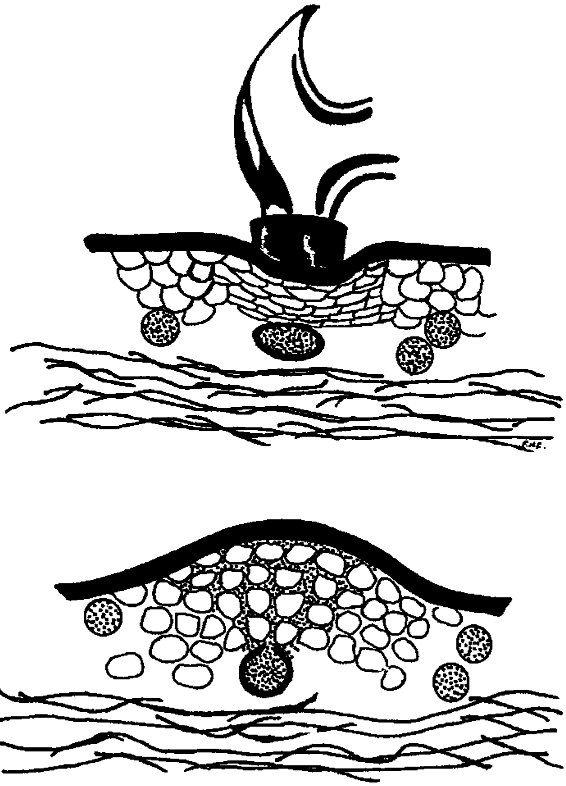


Fig. 4.2 Production of bruising

Bruises can enlarge and evolve over a variable period of time, affected by both movement and gravity, which can mislead as to the actual site of original injury. Further difficulties arise if a bruise, as it extends, tracks along tissue planes from an invisible to a visible location. Bruising of this kind may not become apparent externally for some time and then at a point some distance from the site of the original impact. This delay in the appearance of bruising is of considerable significance since absence of apparent injury at an initial examination is not necessarily inconsistent with bruising becoming apparent 24–48 h later. It is often advisable to conduct a further examination a day or so later and to get sequential photographs taken. Ultraviolet photography may identify injuries no longer visible to the eye [5].

Many bruises (unless patterned or in groups) are nonspecific injuries, and it is usually not possible to offer any detailed opinions on the agent responsible. Some bruises, however, may have a pattern (a patterned bruise), or because of their shape or size or location, may have particular significance. Common types of patterning seen include intradermal (surface) and petechial (pinpoint) bruising which can reproduce the pattern of texture of clothing, the ridge pattern from the sole of a shoe or tire, or the streaky linear purple bruising seen on the neck, wrists, or ankles caused by the application of a ligature. Beating with a rod-like implement can leave a patterned bruise consisting of an area of central pallor outlined by two narrow parallel bands of bruising, so-called tramline bruising (Fig. 4.4).

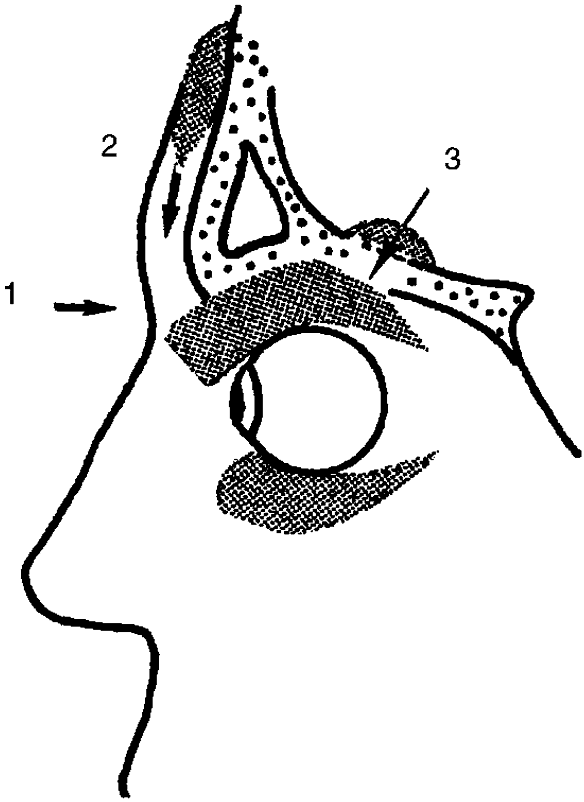


Fig. 4.3 Production of a black eye. (1) Direct blow to the orbit. (2) Injury to the front of the scalp. (3) Fracture of base of skull

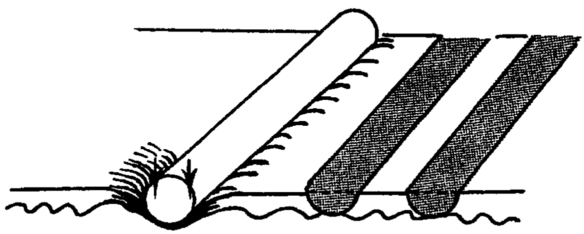


Fig. 4.4 Tramline bruising caused by a blow from a rod-like implement

Other bruises of particular medicolegal significance are the small circular or oval bruises, often up to about 2 cm in diameter (sometime more) characteristic of fingertip pressure from either gripping or grasping with the hand, prodding or poking with the fingers, or the firm impact of a knuckle. They may be seen on the limbs in cases of child abuse when the child is forcibly gripped by the arms or legs and shaken, or on the abdomen when the victim is poked, prodded, or punched.

Such injuries may also be seen after restraint, or when an elderly person has been helped up by gripping the upper arms after a fall. In children, nonaccidental injuries must be differentiated from bruises seen on toddlers and children associated with "normal" activities, play, or sports [17]. Bruises may be seen on the neck in cases of manual strangulation and may be associated with other signs of asphyxia, although fatal strangulation may occur with no external visible evidence of compression.

When sexual assault is alleged, the presence of bruising on the victim may help support the complainant's account and give an indication of the degree of force that was used. For example, grip marks or "defense" injuries may be present on the upper arms and forearms, while bruising on the thighs and the inner sides of the knees may occur as the victim's legs are forcibly pulled apart. Bruising of the mouth and lips can be caused when an assailant places a hand over the face to keep the victim quiet. Also love-bites ("hickeys") may be present often in the form of discrete areas of ovoid petechial bruising, on the neck and breasts. However, it is important to recognize that the latter may be the sequelae of consensual sexual encounters [18].

Abrasions

An abrasion (or a graze) is a superficial injury involving only the outer layers of the skin and not penetrating the full thickness of the epidermis. Abrasions exude serum, which progressively hardens to form a scab, but they may also bleed as occasionally they are deep enough to breach the vascular papillae that corrugate the undersurface of the epidermis in which case frank bleeding may be present at an early stage. More superficial abrasions which barely damage the skin with little or no exudation of serum (and thus no or little scab formation) may be termed "brush" or "scuff" abrasions. Scratches are linear abrasions – typically caused by fingernails across the surface of the skin. Pointed but notcutting objects may also cause linear abrasions, and in order to differentiate them from fingernail scratches, may be termed "point abrasions."

Abrasions are often due to movement of the skin surface over a rough surface or vice-versa (Fig. 4.5). Thus, they may have a linear appearance, and close examination may show elevation of parts of the superficial epidermis to one end, indicating the direction of travel of the opposing surface. Thus, a tangential blow could be shown to have been horizontal or vertical, or it may be possible to infer that the victim had been dragged over a rough surface.

The patterning of abrasions is clearer than that of bruises because abrasions may record a clear impression of the shape of the object causing them and, once inflicted, do not extend or gravitate – therefore they indicate precisely the area of application of force. In manual strangulation, small, crescentic abrasions, caused by the fingernails of the victim or assailant, may be the only signs visible on the neck. A victim resisting a sexual or other attack may claw at an assailant and leave linear parallel abrasions on the assailant's face [19]. Some abrasions may be contaminated with foreign material such as dirt or glass, which may have important medicolegal significance. Such material should be carefully preserved for subsequent forensic

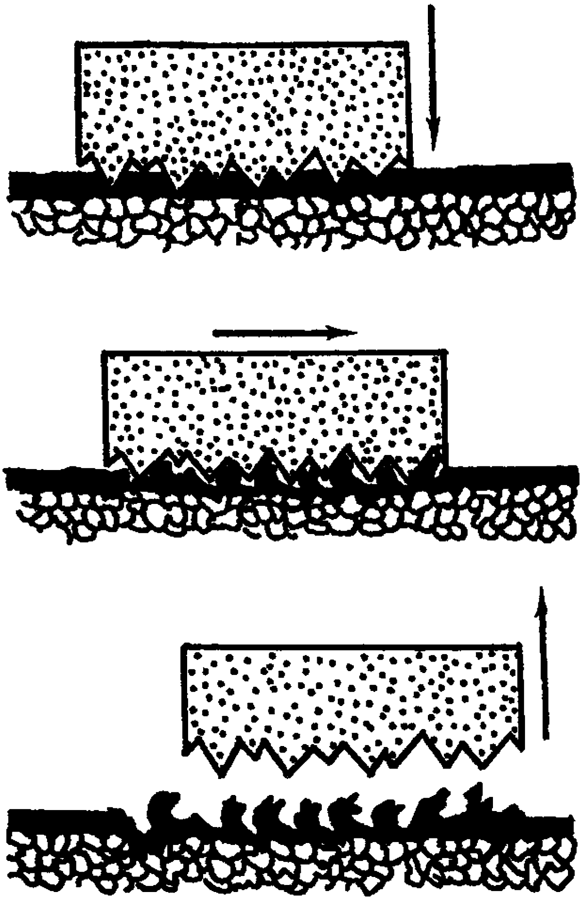


Fig. 4.5 Production of an abrasion

analysis. In such cases, consultation with a forensic scientist can ensure the best means of evidence collection and preservation.

Lacerations

Lacerations are the appearance of cuts & caused by blunt force splitting the full thickness of the skin (Fig. 4.6) – most frequently when the skin and soft tissues are crushed between an impacting object and underlying bone. A typical laceration is one caused by a boxer punching an opponent to the eye with a boxing glove with a laceration being caused by compression of skin between the glove and the orbital rim. As with abrasions – the site of injury is indicative of the site of impact. Lacerations can bleed profusely (particularly on face and scalp). Lacerations have characteristic features, but often mimic incised wounds (or vice-versa) particularly where the skin is closely

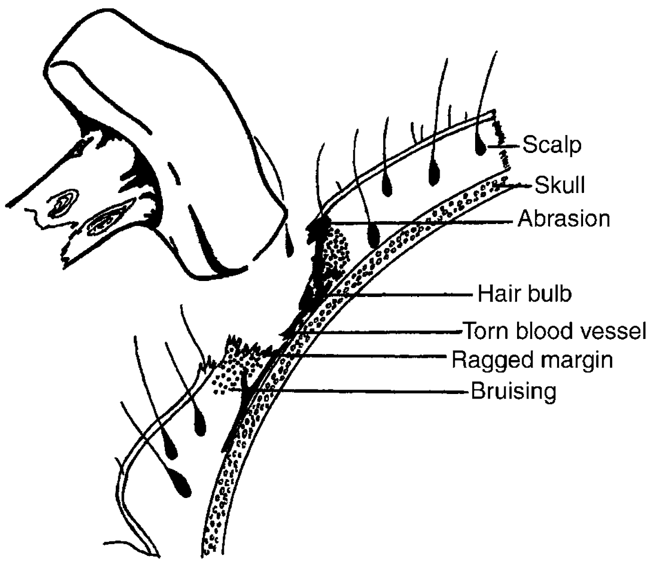


Fig. 4.6 Laceration of the scalp

applied to underlying bone, for example, the scalp. Close examination of the cut can normally resolve the issue. Lacerations are often irregular wounds caused by crushing and tearing of the skin. The margins may be bruised and macerated. Blood vessels, nerves, and delicate tissue bridges may be exposed in the depth of the wound, which might be soiled by grit, paint fragments, or glass.

The shape of the laceration may give some indication as to the agent responsible.

Incisions

Incised wounds are caused by sharp cutting implements, often bladed weapons such as knives and razors, but anything with a cutting edge such as shards of glass, edges of tin cans, and sharp tools such as chisels may also cause clean-cut incised injuries [20]. Axes, machetes, Samurai swords, and other similar instruments, although capable of cutting, may also cause lacerations – as the injury caused by the weight of the instrument (e.g., axe head) may also cause blunt injury. Thus, with such implements, a mixed pattern of sharp and blunt force injury may be seen – with some incised element, some laceration and bruising and swelling and abrasion also present. Each element of the injury must be documented.

The features of an incision contrast with those of a laceration (Fig. 4.7). The margins tend to be clean, straight, unbruised, unabraded, and not inverted. The deeper tissues are all cut cleanly in the same plane. If the blade of the weapon is drawn across the skin while it is lax, it may cause a notched wound if the skin

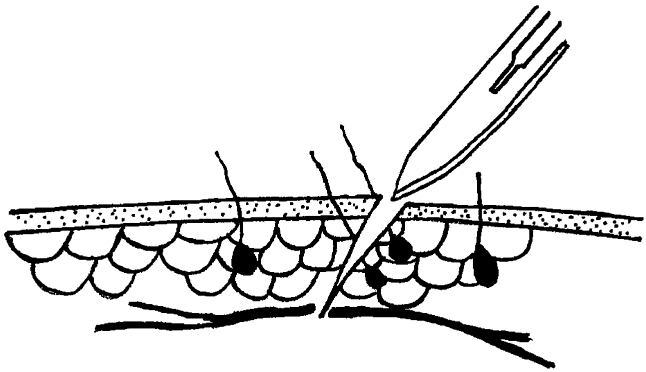


Fig. 4.7 Cross-section of an incision

creases. Similar notching may occur if the sweep or direction of travel of the blade changes.

The head and neck are usual targets when incised wounds are inflicted by an assailant. In an attempt to ward off the assailant, the arms are often raised in a protective gesture, and incisions are then often seen on the ulnar borders of the upper arms, forearms, and little finger side of the hand. If the blade of the attacking weapon is grasped, then incised wounds are apparent on the palmar surfaces of the fingers. Such injuries are known as defense wounds.

Incised wounds may be a feature of suicide or attempted suicide (see below). They are usually located on the wrists, forearms, or neck, although other accessible areas on the front of the body may be chosen. The incisions usually take the form of multiple parallel wounds, most of them being tentative and superficial; some may be little more than simple linear abrasions.

Stab Wounds

Stab wounds are caused by sharp or pointed implements and the wounds having a depth greater than their width or length. This may not be obvious in the living victim. They are usually caused by knives, but can also be inflicted with screwdrivers, pokers, scissors, – but if those implements are not sharp, then the term "penetrating wound" is better applied. Although the external injury may not appear to be particularly serious, damage to vital structures such as the heart, liver, or major blood vessels can lead to considerable morbidity and death, usually from hemorrhage. In those cases that survive, it is common for little information to be present about the forensic description of the wound as the priority of resuscitation may mean that no record is made. If operative intervention is undertaken, the forensic significance of a wound may be obliterated (a) by suturing it or (b) using the wound as the entry for an exploratory operation.

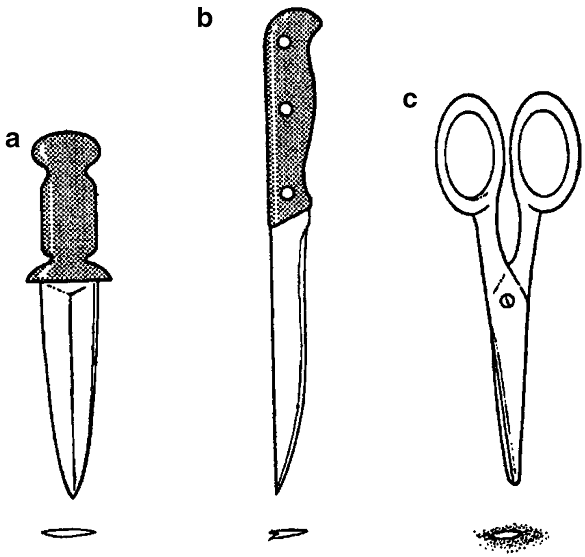


Fig. 4.8 Elliptical (**a**), fish-tailed (**b**), and bruised ovoid (**c**) stab wounds

In such cases, it is appropriate to attempt to get a forensic physician to assess the wound in theater prior to treatment.

Stab wounds are rarely accidental and occasionally suicidal, but usually their infliction is as a result of criminal intent. In the case of suicide, the wounds are usually located on the front of the chest or upper abdomen and, as with self-inflicted incisions, may be associated with a number of superficial tentative puncture wounds (see above). When deliberately inflicted by an assailant, they may be associated with defense injuries to the arms and hands.

The appearance of the skin wound will vary depending on the weapon used and can easily be distorted by movement of the surrounding skin. Typically, when inflicted with a knife, the wound is usually elliptical in shape as the natural elasticity of the skin causes its length to shrink. If the blade was double-edged, such as that of a dagger, the extremities of the wound tend to be equally pointed. A stab wound from a single-edged blade, such as a kitchen knife, will usually have one extremity rounded, squared-off, or fish-tailed (caused by the noncutting back of the blade). When blunt weapons are used, for example, a pair of scissors, the wound tends to be more rounded or oval, with bruising and maceration of its margins (Fig. 4.8). Scissor wounds can sometimes have a pattern such as a cross-shape caused by the blade screws or rivets. Notched wounds are often caused by the blade of the weapon being partially withdrawn and then reintroduced into the wound or rotated during penetration.

It is rarely possible from an inspection of the skin wound alone to comment usefully on the width of the blade since the skin retracts and the knife is unlikely to have been introduced and removed perfectly perpendicularly. Long skin wounds may be caused with quite narrow-width blades.

Table 4.4 Indicators of possible self-harm injuries

Must be on an area of body accessible to the person to injure themselves
Tend to be superficial or minor
Are regular with an equal depth at the beginning and end (for cuts)
Are regular and similar in style or shape (for scratches, burns, etc.)
Are multiple
Are parallel or grouped together
In right-handed persons the injuries are predominantly on the left side (and the converse for left-handed individuals)
There may be lesser injuries where initial attempts at self-harm are made ("tentative" scars)
Tend to involve nonvital structures (e.g., face skin, but not eyes)
There may be old scars of previous self-harm
Overlying clothing may be spared
Absence of defense injuries
There may be a psychiatric history
Consideration should always be made to the possibility of self-inflicted injuries to mimic an assault which may not adhere to typical patterns of such injuries

Self-Harm

Self-harm (or self-injurious behavior) refers to any attempt by an individual to harm themselves and can include self-injury, overdose, or self-hanging. When assessing injuries, it is important to understand which factors may indicate the possibility that an injury was caused by self-harm. Individuals injure themselves for a number of reasons including psychiatric illness, and other, such as attempting to imply events took place that did not, or for motives of gain [21]. Self-inflicted injuries have a number of characteristics, which are not diagnostic, but which together may give an indication of self-infliction. Table 4.4 lists features that may assist in the recognition or suspicion that cuts or other injury, such as scratches, are self-inflicted – all or some may be present – their absence does not preclude self-infliction nor does their presence necessarily imply self-infliction.

Firearm Injuries

The examination of fatal firearm injuries should be left to an experienced forensic pathologist; however, it is not unusual in cases of nonfatal injuries for a hospital clinician or forensic physician to be asked to comment on the nature of the wound or wounds [22]. As with all injuries within the forensic setting, it is essential in these nonfatal cases that the initial appearances of the injuries be accurately described and the wounds photographed. This is particularly important since subsequent surgical treatment may distort or completely obliterate the wound characteristics. Furthermore, any fragments, bullets, or pellets found within the wounds must be carefully removed and handed over to the appropriate authorities. There are two main types of firearm, smooth bore and rifled.

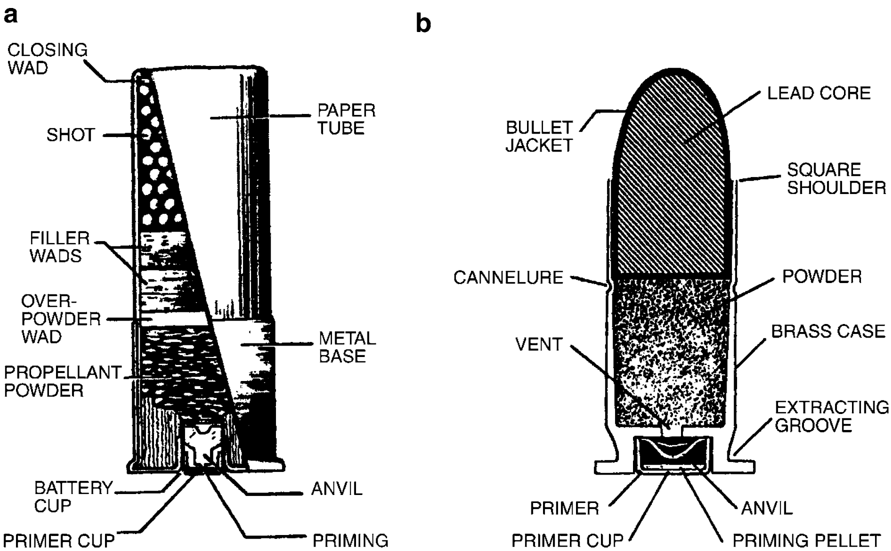


Fig. 4.9 Components of a shotgun cartridge (**a**) and a rifled bullet (**b**)

Smooth Bore Weapons

Shotguns, which fire a large number of small projectiles, such as lead shot, are the commonest type of smooth bore weapons. They are commonly used in sporting and agricultural activities and may be either single- or double-barrelled. The ammunition for these weapons consists of a plastic or cardboard cartridge case with a brass base containing a percussion cap. Inside the main part of the cartridge is a layer of propellant, plastic, felt, or cardboard wads and a mass of pellets (lead shot of variable size) (Fig. 4.9a). In addition to the pellets, the wads and/or cards may contribute to the appearance of the wounds and may be important in estimating range and possible direction.

Rifled Weapons

These are characterized by having parallel spiral projecting ridges (or lands) extending down the interior of the barrel from the breach to the muzzle. This rifling causes the projectile, in this case a bullet (Fig. 4.9b), to spin as it is ejected from the weapon and thus imparts gyroscopic stability along its flight path. The rifling also leaves characteristic scratches, rifling marks, unique to the weapon on the projectile surface. The three main types of rifled weapon are revolver, the pistol, and the rifle. The revolver, which tends to have a low muzzle velocity of the order of 150 m/s, is a short-barrelled weapon with ammunition retained in a rotating metal drum which rotated and loads each time the trigger is activated and a shot fired. The spent cartridge case is retained within the cylinder after firing. In the self-loading pistol, the ammunition is retained in a clip which after firing results in the cartridge case being ejected from the weapon with a spring mechanism elevating the next bullet into the breach. Muzzle velocities of pistols are between 300 and 360 m/s. Rifles are long-barrelled shoulder weapon capable of firing bullets with velocities up to 1,500 m/s. Most military rifles are "automatic," allowing the weapon to continue to fire while the trigger is depressed until the magazine is empty. They are thus capable of discharging multiple rounds within seconds.

Shotgun Wounds

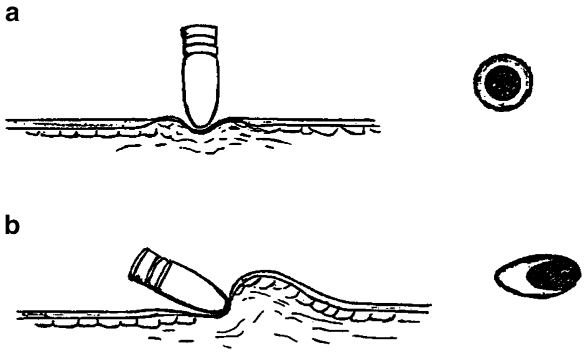
When a shotgun is discharged, the lead shot emerges from the muzzle as a solid mass and then progressively diverges in a cone shape, as the distance from the weapon increases. The pellets are often accompanied by particles of unburnt powder, flame, smoke, gases, wads, and cards, which may all affect the appearance of the entrance wound and are dependent on the range of fire. Both the estimated range and the site of the wound are crucial factors in determining whether the wound could have been self-inflicted.

If the wound has been sustained through clothing, then important residues may be found on this if it is submitted for forensic examination. It is absolutely essential that the advice of the forensic science team and crime scene investigator is sought when retrieving such evidence. When clothing is being cut off in the hospital, staff should avoid cutting through any apparent holes.

Contact wounds are caused when the muzzle of the weapon is held against the skin. The entrance wound is usually a fairly neat circular hole, the margins of which may be bruised or abraded due to impact with the muzzle. In the case of a double-barrelled weapon, the circular abraded imprint of the nonfiring muzzle may be clearly seen adjacent to the contact wound. The wound margins and the tissues within the base of the wound are usually blackened by smoke and may show signs of burning due to the effect of flame. Because the gases from the discharge are forced into the wound, there may be subsidiary lacerations at the wound margin, giving it a stellate-like shape. This is seen particularly where the muzzle contact against the skin is tight and the skin is closely applied to underlying bone, such as in the scalp. Carbon monoxide contained within the gases may cause the surrounding skin and soft tissues to turn pink due to the formation of carboxyhemoglobin. Contact wounds to the head are particularly severe, usually with bursting ruptures of the scalp and face, multiple explosive fractures of the skull, and extrusion or partial extrusion of the underlying brain. Most contact wounds of the head are suicidal in nature, with the temple, mouth, and under the chin being the sites of election. In these types of wounds, which are usually rapidly fatal, fragments of scalp, skull, and brain tissue may be dispersed over a wide area.

At close, noncontact range, with the muzzle up to about 15 cm (6 in.) from the skin, the entrance wound is still usually a single circular or oval hole with possible burning

Fig. 4.10 Entrance wounds caused by perpendicular (**a**) and tangential (**b**) bullet strikes



and blackening of its margins from flame, smoke, and unburned powder. Blackening due to smoke is rarely seen beyond about 20 cm; tattooing from powder usually only extends to about 1 m. The wads and cards rarely travel more than about 2 m.

As distance increases, the pellets begin to diverge. Up to about 1 m, they are still traveling as a compact mass, but between about 1–3 m the pellets start to scatter and cause variable numbers of individual satellite puncture wounds surrounding a larger central hole. At ranges greater than 8–10 m, there is no large central hole, only multiple small puncture wounds, giving the skin a peppered appearance.

Exit wounds are unusual with shotgun injuries as the shot is usually dispersed in the tissues. The pellets, however, may penetrate the neck or a limb, and in close-range wounds to the head, the whole cranium may be disrupted.

Rifled Weapon Wounds

Intact bullets penetrating the skin at 90° to the skin surface (orthogonal contact) usually cause neat round holes about 3–10 mm diameter. Close examination reveals that the wound margin is usually fairly smooth and regular and bordered by an even zone of creamy pink or pinkish red abrasion. A nonorthogonal nose-on strike is associated with an eccentric abrasion collar, widest at the side of the wound from which the bullet was directed (Fig. 4.10). Atypical entrance wounds are a feature of contact or near contact wounds to the head where the thick bone subjacent to the skin resists the entry of gases, which accumulate beneath the skin and cause subsidiary lacerations to the wound margins, imparting a stellate lacerated appearance. Contact wounds elsewhere may be bordered by the imprint of the muzzle and the abraded margin possibly charred and parchmented by flame. Punctate discharge abrasion and sooty soiling are usually absent from the skin surface, but the subcutaneous tissues within the depth of the wound are usually soiled. The effects of flame are rarely seen beyond – 10 cm with sooty soiling extending to ~20 cm. Punctate discharge abrasions, which may be particularly heavy with old revolver ammunition, are often present at ranges up to ~50 cm. Sooty soiling of the skin surrounding a wound is evidence that is easily removed by vigorous cleaning carried out by medical or nursing staff. Also, the soiling of contact close-range entrance wounds may be absent if clothing or other material is interposed between the skin surface and the muzzle of the weapon. Clothing should always be retained.

Exit bullet wounds tend to be larger than entrance wounds and usually consist of irregular lacerations or lacerated holes with everted, unabraded, and unbruised margins. When the skin at the site of an entrance wound has been supported by tight clothing, for example, eversion of the margins of the wound may be absent and the margins may even be abraded although irregularly, but differentiation between these and entrance wounds is sometimes difficult.

Entrance wounds caused by damaged or fragmented bullets may be so atypical that it may not be possible to offer a useful opinion as to their nature. Also, it is inappropriate to offer an opinion on the caliber of a bullet based on the size of an entrance wound nor is it possible to state from the appearance of the wound whether the bullet was fired from a revolver, pistol, or rifle.

Defense Injuries

Certain type of injuries may be described as "defense" injuries. These are injuries that are typically seen when an individual has tried to defend themselves against an attack and are the results of instinctive reactions to assault. These occur in both blunt and sharp force injuries and are natural reactions to assault. Some individuals, for example, the very young and the very old, or those who are intoxicated or already impaired by an assault are less capable of offering much defense against the perpetrators of assault. When attacked with blunt objects, most individuals will attempt to protect eyes and head and neck by raising arms, flexing elbows, and covering the head and neck. As a result, the exposed surfaces of the arms become the impact point for blows. Thus, the extensor surface of the forearms (the ulnar side) may receive blows, the lateral/posterior aspects of the upper arm, and the dorsum of the hands. Similarly, the outer and posterior aspects of lower limbs and back may be injures as an individual curls into a ball, with flexion of spine, knees, and hips to protect the anterior part of the body.

In sharp blade attacks, the natural reaction is to try and disarm the attacker – often by grabbing the knife blade. This results in cuts to the palm and ulnar aspect of the hand. On some occasions, the hands or arms may be raised to protect the body against the stabbing motion resulting in stab wounds to the defense areas.

In blunt force attacks, the injuries sustained usually take the form of bruises if the victim is being punched or kicked, but there may also be abrasions and/or lacerations depending on the nature of any weapon used. If the victim is lying on the ground while being assaulted, he or she will tend to curl up into a fetal position to protect the face and the front of the trunk, particularly from kicks. In these circumstances, defensive bruising is likely to be seen on other surfaces of the trunk and limbs.

The absence of defense injuries in persons otherwise apparently capable of defending themselves against an assault may be of particular significance if it is thought that other injuries found on the victim could have been self-inflicted or if it is believed that they were incapacitated through alcohol, drugs, or other injury.

Torture [2]

The World Medical Association's Declaration of Tokyo in 1975 defined torture as "the deliberate, systematic or wanton infliction of physical or mental suffering by one or more persons acting alone or on the orders of any authority, to force another person to yield information, to make a confession, or for any other reason." The Declaration also laid down guidelines for doctors when faced with cases of suspected torture. The Istanbul Protocol describes all the processes to be followed when assessing allegations of torture. For most clinicians, torture is seen in two main contexts: first, that perpetrated by criminals and terrorist organizations, and second, that carried out, or allegedly carried out, by the police or other security force personnel during the detention and interrogation of prisoners and suspects. Nonjudicial "justice" is now meted out worldwide in a number of ways.

Methods used are fairly crude and barbaric. Fresh injuries or scars of previous injury may indicate previous restraint at wrists and ankles. All types of injury may be seen. Cigarette burns, which seen as discrete circular areas of reddishyellow, parchmented skin, are also quite common. Patterned injuries due to being struck with the butt of a gun or tramline bruising due to blows with a truncheon or baseball bat may be seen; in Northern Ireland, shooting through the lower limbs ("kneecapping") was a favored method of punishment by paramilitary organizations.

Systematic torture by security personnel, usually during interrogation of suspects, ranges from the subtle use of threats and intimidation to actual physical violence. Hooding, prolonged standing, and the use of high-pitched sound have all been used, as have attempts to disorientate prisoners by offering food at erratic times, frequent waking up after short intervals of sleep, and burning a light in the cell 24 h a day. Physical abuse includes beating of the soles of the feet, "falanga," which, although extremely painful and debilitating, may not cause any significant bruising. Adaptations of the use of water causing near drowning (waterboarding or submarino) may prove fatal if prolonged, as can the induction of partial asphyxia by enveloping the head in a plastic bag (dry submarino).

Electric torture is well documented and carries the risk of local electric shocks as well as fatal electrocution. Repeated simultaneous slapping of the sides of the head by the open palms (telefono) may result in tympanic membrane rupture.

In all cases of suspected or alleged ill-treatment of prisoners, it is essential that the doctor carry out a methodical and detailed "head to toe" examination. All injuries and marks must be accurately recorded and photographed and the appropriate authorities informed immediately. Increasingly, forensic physicians are involved in assessments of refugees and asylum seekers to establish whether accounts of torture (both physical and psychological) are true. This role continues to expand and the principles of independent assessment, documentation, and interpretation are, as with other areas discussed, absolutely vital in ensuring that courts and tribunals have the appropriate information to allow fair judgments to be reached [2].

Bite Mark Injuries

Introduction

Biting is a dynamic process and bite marks are complex injuries. The recognition, documentation, analysis, and interpretation of biting injuries is one of the most demanding challenges in forensic dentistry (forensic odontology). Studying and analyzing such patterned marks may demonstrate a link between the dentition of a potential biter and the injury, or link an offender to a crime scene if a bitten object is left behind (Fig. 4.11). Bite mark evidence has been used with increasing frequency over the last decade, possibly due to the raised awareness, recognition, and reporting of these injuries (from a multidisciplinary approach) and also an increase in the number of domestic violence and abuse cases which often involve biting injuries.

Teamwork is essential for the correct management of evidence from such injuries and may involve police, crime scene investigators, forensic scientists, pathologists, forensic physicians, forensic dentists, and legal teams. The transient nature of bite marks in the living, and in perishable substances, means that the investigatory team needs to act quickly and have some understanding of the requirements of the forensic dentist, if valuable information is not to be lost.

Bite mark opinions and conclusions must be carefully considered and free from personal bias: getting it wrong may lead to a miscarriage of justice and incarceration of an innocent person (or release of the guilty).

Over the last decade, improving techniques and developments in digital technology has been instrumental in giving more accurate and reproducible comparison methodology for bite mark analysis. This technology has also helped reduce problems such as photographic distortions, although there is no substitute for correct photographic technique! The forensic sciences are always under scrutiny with regard to reliability, reproducibility, and validity of their techniques and methodologies and it is important that those working in this field continue to make improvements and research all aspects of biting injuries.

Definitions

The term *bite mark* is best described by the following concise statements:

1. A mark caused by the teeth alone, or teeth in combination with other mouth parts [23].
2. A representative pattern left in an object or tissue by the dental structures of an animal or human.

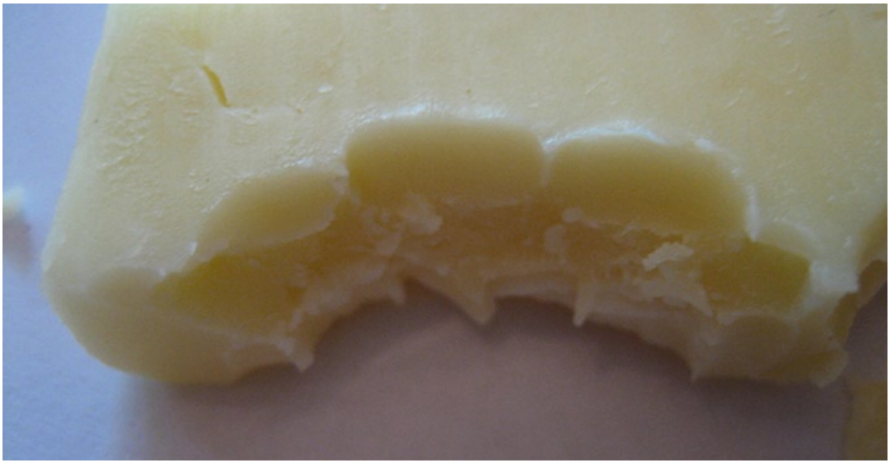


Fig. 4.11 Bite mark in piece of cheese, outlines and indentations of upper and lower anterior teeth clearly visible

Bite Mark Information

The forensic physician will mostly be involved with biting injuries to human skin and any secondary consequences, including infection and disease transmission, but should be aware that bites in foodstuffs and other materials may be present at a crime scene and can easily be overlooked. It is essential that a human bite can be distinguished from an animal bite – thus exonerating (or incriminating) the dog or cat next door! The following pages will consider issues surrounding bites to human skin caused by another human. Early recognition of a patterned injury (suspected of being caused by biting) by medical personnel, social services, and other investigating agencies is extremely important – the injury may be the only physical evidence and must not be lost. Ideally, the forensic dentist should be contacted sooner rather than later when a possible biting injury is discovered in order to ensure that all evidence is collected appropriately. Frequently, the forensic dentist is brought in at a later date when there has been incorrect recording of the bite mark, the injury is partly healed and distorted, or fully healed and no longer visible.

The Questions

Studies of the dentition in large populations inform us that the size, shape, and pattern of the biting surfaces of the upper and lower front teeth within the dental arches are specific to the individual [24] and that significant variability exists in the human dentition [25]. But, how accurately is this pattern recorded on skin?

Fig. 4.12 Multiple bite marks on the upper arm of a child: diffuse bruising – no individual tooth detail visible. The child had numerous other injuries consistent with nonaccidental injury

Only a few studies have addressed factors that can cause distortion of a bite mark on skin [26]. Distortions can occur because of the biomechanical properties of skin and underlying tissue. The degree of this deformation can be influenced by factors such as the anatomical location of the bite site, surface area of the dentition, tissue type, and amount of force applied. It is important to photograph the bite mark with the victim in the same position as when bitten (when possible) to minimize postural distortion.

Recently, some excellent work from the USA has confirmed that there is considerable variation both visibly and measurably when dental models were used to inflict bites (on cadaver skin) both parallel and perpendicular to skin tension lines (Langer lines) and with the limbs in different positions [27]. However, it was noted that consistent distortional trends could be observed when different tissue was bitten [28]. These studies show that an understanding of the properties of skin and its response to applied stress is essential for bite mark interpretation! Discrepancies in the bite pattern in relation to the dentition may be explainable, but caution should be exercised in definitive statements of correlation.

Bites can be found on the victim or the assailant (living, deceased, child, or adult). It is well known that biting is often a feature in nonaccidental injury to children (Fig. 4.12). We must all beware the so-called “amorous” bite and self-inflicted bite.

If a bite mark is found on an anatomical site that is accessible to the person bitten, it becomes necessary to exclude him or her from the investigation.

Initial Considerations

- Is it a biting injury?
- Is it human?
- What should I do?

If the answer to the first question is "don't know," "possibly," or "yes," then request the assistance of the forensic dentist. Make sure that you know which forensic dentist(s) are available in your area; this will prevent delays and frustration. It might also be useful to find out whether your local forensic dentist has experience in bite marks or whether they focus mainly on identifications.

The forensic dentist will examine the suspected biting injury and consider the following:-

- Is the injury oval or rounded in shape?
- Does the injury have central sparing, or is discoloration present from suction or nipping between teeth.
- Are two dental arches visible? Note, however, that a mark from only one arch does not mean that it has not been caused by biting. For example; thick clothing may have protected part of the skin.
- Are marks made by individual teeth within the dental arch clearly visible? Is it possible to differentiate the upper teeth from the lower?
- If so, is detail of that individual tooth visible? Characteristics such as tooth size, shape, displacement, rotations, wear facets etc. will be considered. Individual tooth absences from the arch will be noted.
- Is there sufficient detail for comparisons to be made with the biting edges of the teeth of any particular person or persons?
- Does the appearance of the injury fit the alleged time frame of the incident? *Note*: estimating the age of a bruise is not an exact science! It is widely appreciated that it is easy to miss bruising on dark skins.

When individual tooth characteristics and traits are present in the dentition of the biter and are recorded in the biting injury, the forensic significance of the bite mark is greatly increased. Early involvement of the forensically trained dentist, with experience in biting injuries, is essential to ensure that all dental evidence from both the victim and any potential suspect(s) is appropriately collected, preserved, and evaluated.

There may be insufficient dental detail to enable comparisons to be made with the biting edges of the teeth of any particular person, but, if the injury can be identified as a human bite mark, it may still be significant to the investigation. It is important that the forensic dentist discusses with investigators the evidential value of the bite mark to enable resources to be wisely used.

Differential Diagnosis

It is important to remember that other injuries can mimic bite marks. The following have all been queried as biting injuries:-

- Dermatological and hematological conditions.
- Marks made by ECG electrodes.
- Heel marks.
- Patterned door knobs.
- Burns.

Range of Bite Mark Appearance

- Erythema
- Bruising
- Abrasion
- Laceration
- Avulsion of tissue

In a single bite mark, one, several, or all of the above components may be present and the components may be discrete or superimposed. Furthermore, scrape marks made by tooth movement over skin may be present. However, the situation may become even more complicated when there are multiple bite marks at a single location when they may overlap as the biter tries to get a better "grip;" all these lead to interpretation difficulties.

Helpful Information from Bitten Person (When Possible)

- When were they bitten?
- Has the injury been washed?
- Was the victim clothed over the bitten area?
- How many bites were there?
- What was the victim's position?
- What was the assailant's position?
- Did the victim bite the assailant?

In attempting to get answers to the above questions, a clearer picture of the incident may develop.

Anatomical Distribution of Bitten Sites

The location of the bite mark may vary depending on the type of crime, sex, and age of the bitten person [29,30] and studies show that females are bitten more

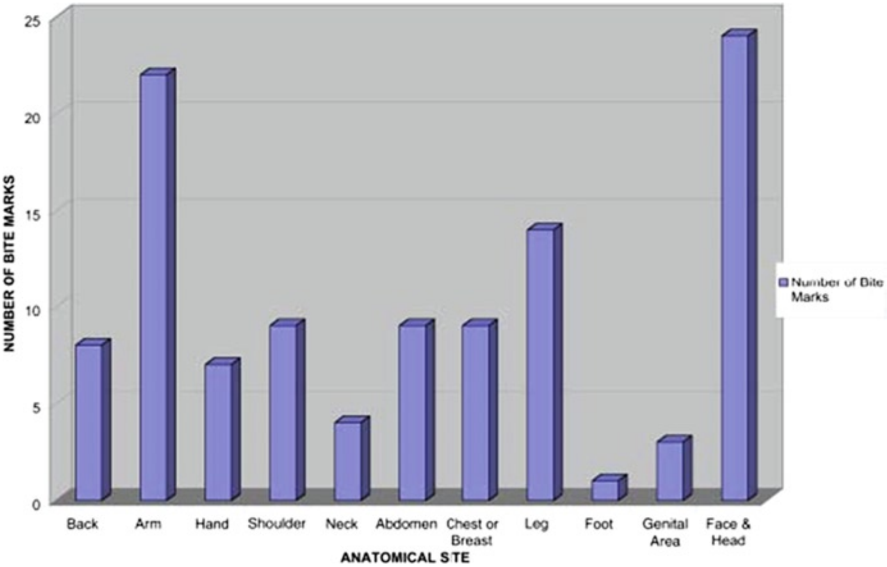


Fig. 4.13 Anatomical distribution of the last 110 bite marks studied by the author (Hinchliffe)

often than males. It can be seen from the anatomical distribution of the bite marks studied by the author (Fig. 4.13) that no part of the body is spared. This graph does not distinguish between male and female, child or adult, or whether there were multiple bites to one person, but serves purely to illustrate that it is essential for medical personnel to thoroughly examine the body for biting injuries and carefully document the findings. This chapter emphasizes the importance of accurately and contemporaneously describing and documenting the injury (anatomical location, nature of the injury, its size, shape, and color). Body diagrams (although of use) do not record detail as faithfully as good quality photographs – photographic documentation (with scales) is essential for bite mark analysis.

In many cases, there are multiple bite marks on the body [31], some that the victim may not be aware of or recall. Multiple bite marks on the body, produced by the same perpetrator, may vary considerably in appearance depending on several factors; these include the anatomy and physiology of the skin and underlying tissue of the site bitten, number of teeth involved, force involved, relative movement between biter and victim, etc. In short, do not jump to the conclusion that there are multiple biters or vice-versa. Nor should it be assumed that a small biting injury has been caused by a child; it may be an incomplete adult bite. Where bruising is diffuse or confluent, size is not always easy to determine. If the marks on the skin can be identified as being made by the smaller deciduous (baby) teeth, this would suggest the mark had been inflicted by a young child.

Case Histories

1. Two playmate toddlers (not related) were left in the care of a 17-year-old babysitter while the mothers went out for the evening. On their return, they blamed the babysitter for the injuries to one of the children (the other child was unharmed). The injuries were identified as human bite marks, but careful examination revealed that they had been caused by deciduous teeth. One of the toddlers had bitten the other one: the babysitter was innocent.
2. An 18-month-old child was brought to the attention of the police by concerned neighbors who saw the child in the garden covered in bruises. On examination, there were several bite marks on the arms, legs and buttocks of the child. The mother and mother's boyfriend were questioned. The male said that the child had been playing with the children next door and must have been bitten by one of them. Fortunately, one of the bites showed enough detail to conclude that it had been caused by an adult with similar dental features to those of the mother's boyfriend. The children next door were excluded from causing the bites – the boyfriend was implicated and subsequently admitted to being the biter.

Evidence collection

As soon as it has been established that the injury has been caused by biting, it should be photographed and swabbed for saliva. In addition, it may be necessary to take an impression of the injured site to preserve any possible indentations (often microscopically detected). Clearly, the taking of forensic samples is not always possible when the injured party needs urgent medical attention. Often the forensic dentist is provided with photographs taken some time after the incident date and following medical intervention (Fig. 4.14); by this time dental evidence has been lost, but it may still be possible to identify the injury as a possible biting injury.

Saliva

Saliva is deposited on the skin (and clothing if present) during biting and sucking. The quantity and quality of this may enable DNA analysis following swabbing of the unwashed injury site. It has been shown that the double swab technique is effective in maximizing the DNA collected [32]. Swabs should be taken as soon as possible to prevent further contamination and DNA degradation. However, it is of interest to note that salivary DNA has been recovered from the bitten breast of a young, deceased woman, although she was found submerged in water [33]. The saliva swabs (with controls) must be clearly and correctly labeled and stored appropriately.

Fig. 4.14 Photograph showing a biting injury to the right ear after medical intervention. Courtesy of Northumbria Police. Used with permission

Buccal swabs (or whole blood samples) will be needed from the bitten person and any potential biter(s), to allow for comparisons with any DNA recovered from the bite site. It may also rule out self-infliction!

Photography

Photographs should be taken when the bite mark is first discovered. It is essential for correct photographic procedures to be followed to minimize distortions. Police photographers, experienced in crime scene and other injury photography, may still find the assistance of the forensic dentist useful, as complications arise from curved surfaces and the correct positioning of the camera and scales. The ABFO no. 2 scale, being small and "L" shaped, is very effective [34] and is now used by many police forces.

As already noted, skin is not the best impression material – various papers and reports have shown the importance of photographing the victim in the same position as when bitten in an attempt to minimize distortion [35]. However, this is not always possible. Changes in the injury with time (in the living and deceased) may mean that the injury pattern appears clearer after a day or two. There is no reliable way of knowing when an injury will reveal the most detail and, therefore, repeat photography (for example, every 24 h for 3–5 days) can prove very useful.

Photography Protocol

- Anatomical location of bite mark (and identification of bitten person).
- Victim in same position as when bitten (when possible).
- Close-up photographs of the bite mark without scales (to show that nothing is being hidden). The film plane or back of the camera should be held parallel to the skin to minimize perspective distortion
- Close-up photographs of the bite mark with scales. Scales should be placed in the same plane as the injury and close to but not obscuring injury detail. The ABFO No. 2 scale has both linear and circular components which help detect and reduce distortion
- Each dental arch may need to be photographed separately when on a curved surface.
- Repeat at intervals.
- Consider other photographic techniques such as ultraviolet photography for older injuries that may no longer be visible.

Most police forces and medical illustration departments are using digital technology for image capture. However, if conventional film is being used, consider asking for photographs to be taken in color and black and white (in addition, black and white with a green filter may be useful). Whatever the method, it is essential that standards, protocols, and appropriate training are in place.

Ultimately, the forensic dentist will select the best images and have them reproduced to life-size (1:1) for analysis and comparison work.

Dental Impressions

Dental impressions taken from the potential suspect by the dentist (or appropriately qualified person) are cast into hard dental models. Procedures should be explained and a thorough dental examination undertaken along with photographs of the biter dentition. It must be remembered that dental impressions taken in custody are intimate samples and require the appropriate authority and consent for your jurisdiction (Police and Criminal Evidence Act 1984, England, Wales and Northern Ireland). The presence of salivary DNA on and around a biting injury may be of particular use if the alleged biter refuses to have impressions taken (or when the bite mark shows insufficient detail to be of great evidential value).

Comparisons

Ideally, the forensic dentist studies the features of the bite mark (to include size, shape, and alignment of the teeth and dental arches, measurements, and angles) before making comparisons with the biter's dentition in an attempt to reduce bias.

The hard dental models of the potential biter(s) dentition are scanned and transparent overlays (hollow volume) of the biting edges of the teeth are produced to facilitate physical comparisons with the images of the bite mark. The use of appropriate software (such as Adobe Photoshop) ensures standardization and reproducibility of technique and gives clear audit trails.

After careful consideration, conclusions are reached and a report submitted to the requesting authority.

Please Remember

1. Although this section is concerned with biting injuries – note that other injuries to the oral cavity and dental structures need to be carefully examined, documented, and photographed, for example: search for fractured teeth or jaw bones, frenal tearing, and other soft or hard tissue damage. If in doubt – contact a forensic dentist (or appropriate dental specialty) for advice.
2. Nonaccidental injury to children (or other vulnerable groups) is covered elsewhere in this book, but it is interesting to note that dentists and their teams (in general dental practice, hospitals, and community services) report less that 1% of abuse cases. However, we all have a professional responsibility to act in the best interests of the patients in our care. In the UK, the General Dental Council's updated *Standards Guidance* booklet [36] states that "the dental team has an ethical responsibility to find out about and follow local procedures for child protection and to co-operate with other members of the dental team and other healthcare colleagues in the interests of patients."

Dental professionals are not responsible for making the diagnosis of child abuse or neglect (as this is much more involved than simply the recognition of injuries), but should be observant and share any concerns appropriately. Teamwork is essential.

Summary

The importance of following the correct procedures for evidence documentation, collection, preservation, and storage (with continuity of evidence) cannot be overstressed.

The biting injury demonstrating plenty of detail (Fig. 4.15) that has been carefully examined, recorded, analyzed, and evaluated can be very useful to the justice system, especially in closed populations, where all probable suspects can be

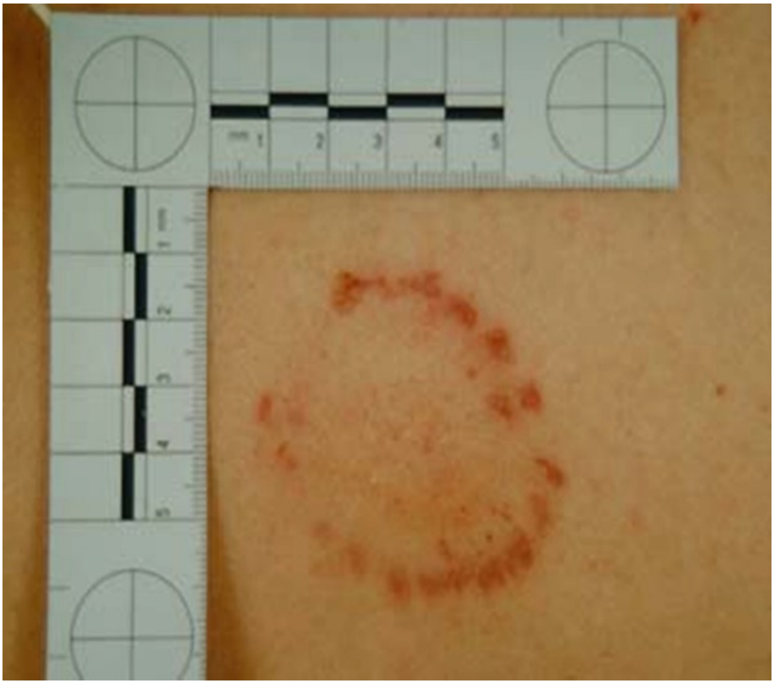


Fig. 4.15 Photograph showing a bite mark on the back with scales. Both dental arches and individual tooth details are visible giving orientation of the injury and facilitating further bite mark analysis

examined [37]. It can establish contact between two people or, of equal importance, exclude an innocent party. But *caution* is needed with conclusions as there are so many variables to consider.

Early suspicion and recognition of patterned injuries by personnel involved with the investigation, followed by prompt and appropriate action, will help maximize the opportunity to collect evidence. Awareness by all concerned and early referral to the forensically trained dentist, with experience in this field, promotes teamwork and best practice.

References

1. Home Office (2010) Crime in England and Wales: Quarterly Updated to June 2010. 2nd Edition. 166/10. Home Office, London
2. Peel M, Iacopino V (2002) The Medical Documentation of Torture. Greenwich Medical Media, London
3. Payne-James JJ (2003) Assault and injury. In: Payne-James JJ, Busuttil A, Smock W (eds) Forensic Medicine: Clinical and Pathological aspects. Greenwich Medical Media, London, pp 543–563
4. Gall J, Payne-James JJ (2011) Injury interpretation – possible errors and fallacies. In: Gall J, Payne-James JJ (eds) Current Practice in Forensic Medicine. Wiley, London
5. Marsh N (2011) The photography of injuries. In: Gall J, Payne-James JJ (eds) Current practice in forensic medicine. Wiley, London

6. Irvine AJ (2002) Incisions, are not lacerations. Br Med J 325:1113–1114
7. Henn V, Lignitz E (2004) Kicking and trampling to death: pathological features, biomechanical mechanisms, and aspects of victims and perpetrators, Chapter 2. In: Tsokos M (ed) Forensic Pathology Reviews volume 1. Humana Press Inc, Totowa
8. Dolinak D, Matshes E (2005) Blunt force injury, Chapter 5. In: Dolinak D, Matshes EW, Lew EO (eds) Forensic Pathology – Principles and Practice. Elsevier Academic Press, London
9. Karger B, Rothschild MA, Pfeiffer H (2001) Accidental sharp force fatalities – beware of architectural glass, not knives. Forensic Sci Int 123:135–139
10. Karger B, Niemeyer J, Brinkmann B (2000) Suicides by sharp force: typical and atypical features. Int J Leg Med 113:259–262
11. Bleetman A, Hughes Lt H, Gupta V (2003) Assailant technique in knife slash attacks. J Clin Forensic Med 10:1–3
12. Bleetman A, Watson CH, Horsfall I, Champion SM (2003) Wounding patterns and human performance in knife attacks: optimising the protection provided by knife resistant body armour. J Clin Forensic Med 10:243–248
13. Langlois NEI, Gresham GA (1991) The ageing of bruises: a review and study of the colour changes with time. Forensic Sci Int 50:227–238
14. Stephenson T, Bialas Y (1996) Estimation of the age of bruising. Arch Dis Child 74:53–55
15. Munang LA, Leonard PA, Mok JYQ (2002) Lack of agreement on color description between clinicians examining childhood bruising. J Clin Forensic Med 9(4):171–174
16. Maguire S, Mann MK, Sibert J, Kemp A (2005) Can you age bruises accurately in children? A systematic review. Arch Dis Child 90:187–189
17. Maguire S, Mann MK, Sibert J, Kemp A (2005) Are there patterns of bruising in childhood which are diagnostic or suggestive of abuse? A systematic review. Arch Dis Child 90:182–186
18. Payne-James JJ (2009) Assault: sexually motivated. In: Jamieson A, Moenssens A (eds) Wiley encyclopedia of forensic science. Wiley, New York
19. Payne-James JJ (2011) Asphyxia. In: Wyatt J, Norfolk G, Squires T, Payne-James JJ (eds) Oxford Handbook of Forensic Medicine. OUP, Oxford
20. Payne-James JJ, Vanezis P (2005) Sharp and cutting-edge wounds. In: Payne-James JJ, Byard R, Corey T, Henderson C (eds) Encyclopedia of Forensic and Legal Medicine. Academic, Amsterdam
21. Gall J, Payne-James JJ, Goldney RD (2011) Self-inflicted injuries and associated psychological profiles. In: Gall J, Payne-James JJ (eds) Current practice in forensic medicine. Wiley, London
22. Dana S, DiMaio VJM (2003) Gunshot trauma. In: Payne-James JJ, Busuttil A, Smock W (eds) Forensic Medicine: Clinical and Pathological Aspects. Greenwich Medical Media, London, pp 149–168
23. MacDonald DG (1974) Bite mark recognition and interpretation. J Forensic Sci Soc 14:229–233
24. Rawson RD, Ommen RK, Grams K, Johnson J, Yfantis A (1984) Statistical evidence for the individuality of the human dentition. J Forensic Sci 29:245–253
25. Kieser JA, Bernal V, Waddell JN, Raju S (2007) The uniqueness of the human anterior dentition: a geometric morphometric analysis. J Forensic Sci 52(3):671–677
26. Sheasby DR, MacDonald DG (2001) A forensic classification of distortion in human bitemarks. Forensic Sci Int 122(1):75–78
27. Bush MA, Miller RG, Bush PJ, Dorion BJ (2009) Biomechanical factors in human dermal bitemarks in a cadaver model. J Forensic Sci 54(1):167–176
28. Bush MA, Thorsrud K, Miller RG, Dorion RBJ, Bush PJ (2010) The response of skin to applied stress: investigation of bitemark distortion in a cadaver model. J Forensic Sci 55(1):71–76
29. Pretty IA, Sweet D (2000) Anatomical locations of bite marks and associated findings in 101 cases from the United States. J Forensic Sci 45:812–814
30. Freeman AJ, Senn DR, Arendt DM (2005) Seven hundred and seventy-eight bite marks: analysis by anatomic location, victim and biter demographics, type of crime, and legal disposition. J Forensic Sci 50:1436–1443
31. Vale GI, Noguchi TT (1983) Anatomical distribution of human bite-marks in a series of 67 cases. J Forensic Sci 28:61–69

32. Sweet D, Lorente JA, Lorente M, Valenzuela A, Villanueva E (1997) An improved method to recover saliva from human skin: the double swab technique. J Forensic Sci 42:320–322
33. Sweet D, Shutler G (1999) Analysis of salivary DNA evidence from a bite mark on a body submerged in water. J Forensic Sci 44:1069–1072
34. Hyzer WG, Krauss TC (1988) "The bite mark standard reference scale – ABFO No. 2. J Forensic Sci 33(2):498–506
35. Barbenel JC, Evans JH (1974) Bite marks in skin – mechanical factors. J Forensic Sci Soc 14(3):235–238
36. GDC (2005) Standards for dental professionals. http://www.gdc-uk.org. Last Accessed 01 Oct 2010
37. Senn D (2007) A critical look at the forensic value of bite mark analysis. Forensic Odontology News, American Society of Forensic. Odontology 1:6–9

Chapter 5
Physical Child Abuse

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Introduction

Physical child abuse is common and carries a significant morbidity and mortality. Child health professionals have an important role in recognizing, assessing, and managing children with suspected physical abuse.

Definition

In Western societies, physical abuse is recognized as one of four categories of child maltreatment, along with sexual abuse, emotional abuse, and neglect. It is well accepted that these categories may coexist in the same child or young person (definition: a person under the age of 18 years [1, 2]). Physical child abuse is an act of commission, both deliberate and intentional, although the intended consequence to the child may not be planned. For example, a carer may hit a child as a punishment but not intend to cause a serious injury [3]; nevertheless, such an act may cause significant physical and emotional harm and amounts to maltreatment. The UK Children Act 2004 states that "physical abuse may involve hitting, shaking, throwing, poisoning, burning or scalding, drowning, suffocating or otherwise causing physical harm to a child. Physical harm may also be caused when a parent or carer fabricates the symptoms of or deliberately induces illness in a child." Although each state in the United States is responsible for providing its own definition of child abuse and neglect, this description broadly encapsulates an internationally agreed definition of physical

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abuse. Debate continues, however, in some circles, around the influence and attitudes of societies, cultural differences in child rearing, politics, and religious beliefs on what constitutes child abuse.

A unified definition is important to inform a general framework for child protection policy setting, multi-agency assessment, statutory and legal interventions, epidemiology, and an understanding of current and future research.

Epidemiology

The true prevalence of physical child abuse is difficult to determine. The number of cases that are recognized by statutory child protection agencies is the tip of a much bigger iceberg of victims who never come to their attention. Many cases go unreported or unrecognized. Information systems are incomplete or record a limited part of the picture. Alternatively, estimates are on the basis of self reporting from victims or surveys of adults about their childhood experiences. A recent review of all available data concludes that between 4 and 16% of children are physically abused every year in high-income countries [4]. Many of these children are victims of repeated episodes of abuse which start in early childhood.

Risk Factors for Abuse

Social, psychological, physical, economic, and environmental factors in the carer and the child may all contribute to an increased risk of child abuse [4]. The way that these factors interact to increase risk is complex and ill understood. Carer-related factors include interpersonal violence within the household, substance misuse, known maltreatment of animals, poverty, mental health problems, low educational achievement, and exposure to maltreatment as a child. Child-related factors are disability, and emotional and behavioral problems [5] and socio-economic factors include single parent, young parent, new partner, poverty, family and neighborhood stress, and unemployment [6, 7]. The causal relationship between individual and associated factors is not inevitable as some households burdened with a number of risk factors develop resilience and are not abusive households.

Consequences of Physical Abuse

Physical abuse carries a significant mortality and morbidity. Child homicide figures reflect the most severe cases of physical child abuse. In the United Kingdom, between one and two children die from child abuse every week, while

US child abuse mortality figures are as high as 2.35/100,000 annually [8]. The most serious abusive injuries include abusive head trauma (AHT) and visceral injuries. Both occur in the youngest children and have an estimated mortality rate of 12–30% [9, 10].

Significant neurological disability is seen in around half of the survivors of AHT [9] and many victims of abusive thermal injury sustain serious scarring and disfigurement. In terms of psychological outcome from physical abuse, it is difficult to disentangle the effects of associated types of abuse such as neglect and emotional abuse. However, studies confirm emotional and behavioral problems, post traumatic stress disorder, mental health problems, substance misuse, and criminality in survivors of abuse [4]. Early identification of physical abuse and early intervention are essential to prevent ongoing abuse and avoid its consequences.

Physical Abuse

Physical child abuse results in a wide range of injuries that include the following:

- Bruising and soft tissue injuries that include bites and abrasions
- Burns and scalds
- Skeletal injury
- AHT
- Visceral injury

Any clinician, indeed anyone who sees children on a regular basis, has a responsibility to recognize and report suspected physical abuse to statutory child protection agencies. Children with suspected physical abuse are referred to pediatricians with child protection expertise to assess and investigate the child, to manage its injuries and determine the likelihood that injuries sustained are abusive or not. The pediatrician will become part of the multidisciplinary team involved in consensus decisions about the probability of abuse and the ongoing risk to the child. He/she is then involved in the legal child protection process and may be expected to give opinion in Court as a professional or expert medical witness.

Assessing a Child with Suspected Physical Abuse

Forensic physicians need to ensure that children with suspected physical abuse receive a detailed assessment by a pediatrician with expertise in the field. In the absence of witnessed or admitted child abuse, a diagnosis of physical abuse can only be made on the balance of probability as there is no gold standard diagnostic test for the condition. The clinical team has a responsibility to undertake a comprehensive assessment of the child, and a duty to be familiar with the scientific evidence so that they can piece together information to support their clinical opinion remembering that it is the welfare of the child that is paramount.

The assessment must include a full evaluation of the child's general physical, developmental, emotional, and behavioral welfare as well as a detailed assessment of the injuries that the child has sustained. This requires a clinical approach to determine the severity of injury and need for treatment, together with a forensic assessment of the pattern of injury in the context of the proposed explanation, to determine the likelihood of child abuse. A thorough evaluation of the child is required including investigations to identify the full profile of associated injuries. The abuse may involve other siblings and family members, who should be included in the assessment. Infants and young children are at the greatest risk of serious physical injury and the most challenging to assess because of the sometimes occult nature of their injury and their inability to contribute to the history of preceding events themselves.

Cases of suspected physical abuse are referred to the pediatrician from social services or child protection teams, who have been alerted to the children following concerns expressed by members of the public, teachers, or health workers. A child may be referred from the emergency departments or inpatient units for a specialist opinion when clinicians raise concerns about unexplained or suspicious injuries. A pediatrician may also become involved in the assessment of sudden unexpected death of a child when concerns regarding suspected child abuse are raised.

History

The pediatrician must take a thorough account of the preceding events and circumstances that led to the injuries that the child has sustained. Clear documentation of all relevant details is essential, as these will have bearing on the future protection of the child, and decisions in any legal proceedings.

It is widely accepted that certain features in a history raise concerns about physical abuse [11]. These include significant injuries where the cause is unexplained, or where the explanation is vague or detail is lacking or inconsistent; injuries that are inconsistent with the explanation given or where the explanation is inconsistent with a child's level of motor development. To make decisions regarding the plausibility of an explanation, it is important to know when or where the injury was sustained and details of the nature of the causative event; for example, if a fall is the proposed mechanism of injury it is essential to know the height of the fall, what the child was doing at the time, the nature of the surface of impact, and the anatomical site of impact.

These details must be collected, in the context of the social, family, health, behavioral and developmental history of the child, to gain information regarding associated risk factors and to assess findings within a comprehensive family context.

Bruising

Bruising remains the commonest abusive injury that children sustain [12, 13], and as such may be an important indicator that abuse has taken place, and that further enquiries / investigations are merited. Missing abusive bruising may be a lost opportunity to protect a child; it has been noted that 19% of children who were fatally abused had been seen by a doctor within the month prior to their death, and facial bruising was among the injuries seen [14]. However, children will sustain bruises during their normal day to day activities, and the challenge is to accurately distinguish these two. While accidental bruising is extremely rare in pre- mobile infants (<1%), with the exception of birth related bruises [15, 16], bruising is the commonest finding in abused babies, and the face is a frequent site of abusive bruises [17, 18]. Accidental bruises are clearly linked to mobility; it is estimated that 17% of children have bruises at any one time once they are crawling or cruising, increasing to 50% in those walking [15, 19]. Bruises to a *nonmobile child* should always alert a physician to the possibility of abuse.

When accidental bruises are present, they tend to occur over bony prominences [15]; accidental facial bruises in young toddlers are found in a “T” distribution, that is, over the forehead, nose, upper lip, and chin [20]. In contrast, abusive bruises to the *face* are predominantly over soft tissue, such as the cheeks, mouth, and periorbital areas [21]. The *neck and ears* are very rarely bruised accidentally, at any age, but abusive bruising occurs here [22] and in some cases a “tin ear syndrome” may be found (i.e., bruising to the pinna, ipsilateral subdural hemorrhage, retinal hemorrhage) [23].

Once a child reaches school age, almost 80% will have some accidental bruising [16]. However, even among these children certain sites are commonly bruised (shins, forehead, arms) [15, 24], yet bruising to the hand is rare at all ages [17, 24] while bruising to the ears, thighs, abdomen, and buttocks is significantly commoner among abused than non-abused children [17]. If petechiae are found with the bruising, in the absence of an underlying coagulopathy, the bruise is significantly more likely to be abusive in origin, with a positive predictive value of 80% (95% CI 64.1, 90.0); however, the absence of petechiae has no significance either way [25]. On some occasions, either the positive or negative imprint of the weapon causing the bruise may be visible, emphasizing the need for high quality imaging of the bruise, as this may enable matching of the outline to a proposed object used to assault the child (e.g., belt buckle, dog collar, etc.) [26, 27].

Clearly, bruising may be a consequence of bleeding disorders, and as such, any investigation of a child with bruises of possible significance should include an appropriate screening for coagulation disorders, including FBC, Clotting Screen, Von Willebrand Factor, and PF100; if any history suggestive of a bleeding disorder (bleeding after dental extraction, prolonged bleeding from umbilical cord, etc.) is present, then the case should be discussed with a pediatric hematologist, as to the need for an extended screen of clotting abnormalities. As with all children, a detailed past medical history (e.g., in the case of an infant, was Vitamin K administered following birth, etc.), previous episodes of prolonged bleeding or bruising, drug history (e.g., regular use of NSAID), and a family history of bleeding disorders should be sought.

Clinicians are often asked to date the bruises present, and it has long been the practice to do so on the basis of the color of the bruise [28]. However, there is no published scientific evidence to support such an estimation [29], and indeed recent studies have shown that the same observer cannot always agree with his/her own assessment of the color of a bruise when reviewing photographs of the same bruise over time [30]. There are many valid reasons why we are unable to age bruises on the basis of assessing them visually, including differing color perception among individuals, depth of the bruise, skin color, varying subcutaneous tissue, and presence or absence of an underlying fracture.

Oral Injury

As the head is one of the commonest areas of the body to be injured in abuse, it is surprising that intraoral injuries are not recorded more frequently, being found in only 6–11% of abused children [31, 32]. However, all of the studies to date have been retrospective, begging the question as to how often the mouth has actually been fully examined. It is a vital part of the assessment of suspected abuse, as almost all forms of intraoral injury have been described abusively – torn labial/lingual frenum, dental intrusions, extrusions, fractures, laceration, and even bites to the tongue. [33]. A torn labial frenum has been deemed to be "pathognomonic" of child abuse in young children, as its earliest descriptions by Cameron and later Tate recorded this injury in severely abused children [34, 35]. Yet, it is recognized that this injury can occur, in mobile toddlers and older children, who accidentally sustain a direct blow to the upper lip, or during resuscitation [36, 37]. Unfortunately, there are no large scale comparative studies defining the pattern of such injuries found accidentally and abusively. What is clear, however, is that when a torn labial frenum occurs in child abuse, it is usually accompanied by severe, if not fatal, coexisting injuries [34, 36, 38]. As such, it is imperative that any infant or young child found to have a torn frenum should be fully investigated, as failure to do so may lead to the child being sent home, and subject to further abuse [39]. However, if full physical assessment, including a skeletal survey in those <2 years of age, and a full social assessment, does not reveal any other abnormal findings or concerns, a torn frenum *in isolation* cannot be assumed to be abusive.

Other oral findings may be relatively subtle to pediatricians, including microfractures which lead to gray discoloration of the teeth [40]. Likewise, the discoloration found in dentinogenesis imperfecta is an important finding as this may coexist with osteogenesis imperfecta, an important differential diagnosis of fractures in a young child [41]. It is important for examining clinicians to know the expected primary/secondary dentition, as there have been reports of forced extraction of the teeth by parents as a form of "punishment" [42]. This highlights the need for clinicians to work closely with their dental colleagues (and vice versa) in the event that any unexplained or unusual intraoral findings are identified.

Bites

Bites are a common injury in childhood [43], predominantly caused by other children or animals. Animal bites, such as dog bites, are easily distinguished from human bites. Animals have a longer narrow jaw, and tend to tear at flesh rather than crush it [44]. Children sustain abusive bites in any location, but the commonest appear to be arms, legs, back, shoulders, and buttocks [45]. A human bite is described as 2–5 cm oval or circular injury, with a circumscribed annular border, with or without central ecchymosis. This is usually composed of two opposing concave arcs. There may be associated petechiae within or around this. Classically, measurement of intercanine distance [46] is used to distinguish child and adult bites: An intercanine distance of 2.5–4.5 cm is consistent with an adult human bite, less than 2.5 cm: a child (deciduous teeth), 2.5–3.0 cm: a child or small adult, and greater than 3.0 cm: an adult.

However, it must be borne in mind that there can be racial and individual differences in intercanine distances, and that "adult" dentition is reached by 12 years of age. Nonetheless, it is vital to identify an adult bite on a child, as it is the only physical injury which may afford the opportunity to identify a specific perpetrator, either by retrieval of DNA from the bite itself, or by reconstruction of the dentition of the perpetrator by a forensic dentist [47]. This is just as important to rule in as to rule out a specific suspect. Sometimes, bites can be confused with dermatological disorders, such as ring worm; however, a key difference here is the presence of scaling in dermatological disorders.

Given the potential significance of an abusive bite, it is vital that appropriate photographs are taken at the time, using a right angled measuring device, and if the bite is on a curved surface (e.g., upper arm) to take photos in each plane. A forensic dentist should be contacted as soon as possible; forensic dentists can be located throughout the UK via the website, http://www.bafo.org.uk [48]. In the event that a child cannot be seen immediately by a forensic dentist, serial photographs on a daily basis may be helpful, as the precise dental imprints can become clearer over time as the surrounding induration reduces.

Thermal Injury

It is estimated that up to 10% of children admitted to burns units, may be suffering from an abusive burn [49], with burns due to neglect outnumbering intentional burns 9:1. Abusive burns not only carry a higher mortality, but they lead to significant short and long term morbidity with the need for frequent dressing changes, surgery, and possible scarring and contractures in addition to the psychological consequences [50].

The commonest intentional burns described in the literature are scalds, with hot water immersion burns being the commonest pattern [51–53]. While the typical pattern for abusive scalds involves the feet and legs, with or without buttocks / perineum, it may also involve both hands and feet, or one hand, or may involve only the face [51, 54]. Classically, these burns have a consistent burn depth, and have a clear upper margin [55], sometimes giving rise to the "glove and stocking" appearance [53, 56]. This pattern contrasts with the typical accidental scald, which occurs as a "spill over scald" where the child reaches up and pulls a hot drink over itself, scalding its face, upper limb, and upper trunk [57]. Here, the burn is deepest at the point of contact with the hot liquid and decreases in depth as the liquid reduces in heat and amount as it flows away from this point. With the increasing use of microwaves and "ready meals," there has been an increase in accidental spill burns due to hot food items in older children or to a small child who is in the care of a teenager. Burns are one injury where the injury found is directly related to the causative agent and duration of exposure. As it only takes 1 second for a child to sustain a full thickness burn from a liquid at 60°C [58], if the history is that the child accidentally immersed itself in the bath water for only a matter of seconds, it is vitally important to find out what temperature the domestic water temperature in the house is set at, a fact which surprisingly few people know about their own home [59]. Likewise, if it is suggested that the child climbed into the basin and turned the tap on itself, causing a running water burn, a home visit is necessary combined with an appropriate developmental assessment [60]. Could this child have climbed into that basin? What way was he facing when the parent came into the bathroom? In other words, if the burn is on the left leg, would this have been the leg closer to the hot tap in that particular basin? When assessing a potentially abusive scald, it is important not only to assess the burn itself (agent, pattern, mechanism, distribution) but also to look for other risk factors, for example, are there other unrelated injuries at the time of the burn, was a sibling blamed, have there been previous burn injuries, is it developmentally appropriate, is there interpersonal violence in the home, have there been frequent emergency attendances, is the child behaving abnormally in light of such a painful and distressing injury [54]? Any child with a suspicious burn, aged less than 2 years, should undergo a skeletal survey, as it is recognized that up to 14% of children with abusive burns may have occult fractures [62].

Children may sustain other abusive or neglectful burns, such as radiation burns (sunburn), contact burns (e.g., from domestic irons) [63], caustic burns [64], and microwave burns [65]. While there are no uniform criteria for diagnosing abuse in these situations, the key message is to be vigilant, and take a very careful history to ensure that the injury found is compatible with the child's development, the agent, and way it is supposed to have occurred (e.g., if a child has an iron burn, clearly demarcated, full thickness on the back, this is unlikely to be consistent with pulling an iron down on itself). With the increasing use of hair curlers / straighteners among teenagers, there has been a rise in accidental burns among toddlers from such devices [66]. These may cause burns to both the dorsal and plantar aspects of the foot as the toddler stands on straighteners left on the floor and the straighteners flip over and makes contact with both aspects of the foot, or the toddler snaps it onto its foot. Parents often do not realize that these devices may reach temperatures of around 145° within 2 min, and stay hot enough to cause full thickness burns for up to 7 min after they are turned off.

Unfortunately, no study compares the features of accidental vs. intentional cigarette burns; the few intentional ones recorded in the literature were circular / punched out lesions approximately 1 cm in diameter [67].

One area of difficulty in assessing burns is the child who has been “treated” with moxibustion, a form of traditional remedy. This involves burning the Moxa herb directly over the site of the symptoms (e.g., around the umbilicus in abdominal pain), thus producing a series of circular well demarcated burns; likewise “cupping” can cause multiple circular superficial burns. While these may have been “inflicted” on the child, they are intended to be “therapeutic” for the underlying condition, and it is important that clinicians are aware of such practices, particularly among South Asian families. Likewise, it needs to be borne in mind that children with Attention Deficit and Hyperactivity Disorder (ADHD) do sustain more accidental burns than the rest of the childhood population [68], and this may not reflect neglect as such but highlight the challenge parents have in preventing such accidents in this group of children.

Abdominal Injuries

Although abdominal injuries are rarely recorded in abused children, prevalence estimated at 1–8% of abuse cases, they are recorded as the second commonest cause of fatal abuse after head injuries [10]. Among abdominal injuries, liver and bowel injuries occur with almost equal frequency, although it is worth noting that accidental duodenal injury, which is the commonest abusive bowel injury recorded in the literature, is an extremely rare accidental injury in children less than 4 years of age, and no small bowel injuries have been recorded in children <5 years old as a consequence of a fall [10]. Almost every organ in the abdomen has been injured abusively, but the true prevalence of these injuries is difficult to determine because of the lack of high quality epidemiological data. It is estimated in the United Kingdom that 0.9 cases/million children/year (95% C.I; 0.58–1.39) present with an abusive abdominal injury [69].

The clinical presentation of those with abusive abdominal injury varies; bruising to the abdomen may be present in up to 60% of cases [69], but other studies note that up to 90% of children had no abdominal bruising [70]. Lindberg et al. [71] have attempted to assign a probability of abusive abdominal injury in the presence of abdominal bruising, where they estimated a positive likelihood ratio of 7.9, and a negative likelihood ratio of 0.7; thus, its presence is highly suspicious, but its absence does not mean serious injury is not present. Abdominal symptoms, for example, distension, vomiting, reduced bowel sounds, and tenderness were all positively associated with significant injury, although significant injury can be present in the absence of these signs [71]. Although abusive abdominal injuries tend to occur in younger children than accidental abdominal injuries (2.5–3.7 vs. 7.7–10.39 years), and hollow organ injuries are commoner among this group, alone or in combination with solid organ injuries, there are few other distinguishing features [72]. Delayed presentation was not a discriminator as children with low velocity accidental injuries also presented late. A high index of suspicion should be used if a child <4 years presents with abdominal symptoms suggestive of internal injury, without an explicit history of blunt injury, and in such cases the optimal investigation is a CT scan of the abdomen with IV contrast.

Fractures

Most skeletal injuries in physical abuse occur in children under the age of 2 years. In 1986, Worlock et al. [73] showed that 80% of abusive fractures occurred in children under 18 months while 85% of accidental fractures are seen in children aged 5 years and over. Abusive fractures are frequently clinically occult; they may be multiple and of different ages [73, 74]. Any fracture can occur as a result of physical abuse, but some have a higher specificity than others.

Rib fractures have the greatest specificity for physical abuse [75, 76]. The fractures are most likely to be multiple, affecting ribs on one or both sides of the thorax. They can be located at any point along the ribs; anterior rib fractures appear to be more common in abuse than nonabuse, and lateral fractures are more commonly seen in accidental injury, while posterior rib fractures are reported in both situations.

Humeral and femoral fractures have a higher risk of being abusive than accidental in children under 18 months of age. However, Pandya [76] shows that in children over 18 months of age both humeral and femoral fractures are more likely to be accidental. As far as fracture types are concerned, supra condylar humeral fractures are strongly indicative of an accidental injury [77]. There is no difference between the type of femoral fracture in abusive and nonabusive injuries which are most commonly mid shaft, with the exception of spiral fractures that were recorded as the most common abusive femoral fracture in children under 15 months of age [78].

The skull is the commonest fracture site in both abuse and nonabuse and the commonest fracture type from either cause is linear parietal. However, it is estimated that as many as one in three skull fractures in preschool children are abusive [75, 76].

Metaphyseal fractures have been described as characteristic of physical abuse. However, there are no comparative studies to confirm this; metaphyseal fractures are certainly described more frequently in abuse [73, 79, 80] than following accidental injury. However, they have also been described as birth related injuries [81] and following serial casting treatment of talipes deformity [82]. The presence of unexplained metaphyseal lesions in an infant always warrants further child protection investigations.

Skeletal spinal injuries are reported in physical abuse. Cervical injuries have been reported in association with AHT in babies and thoraco-lumbar fracture dislocations in toddlers [83]. These injuries may be associated with injury to the spinal cord. If spinal skeletal injuries are suspected, a spinal magnetic resonance imaging (MRI) scan should be conducted to exclude spinal cord involvement.

Fractures at any anatomical site have been described in the international literature in case studies and small case series (http://www.core-info.cf.ac.uk).

Radiological Investigation in Children with Suspected Abuse

Skeletal fractures have been described in up to one-third of children who have been physically abused [84]. In light of the fact that children under 2 years of age are at greatest risk and that fractures may be clinically occult, it is important that skeletal injuries are excluded in any child under 2 years of age when physical abuse is suspected. Both the American Association of Pediatrics and the Royal College of Radiology and Royal College of Paediatrics and Child Health set out guidelines for the radiological investigation of these children [85, 86]. Both recommend an initial comprehensive skeletal survey that includes up to 20–21 X-ray images to visualize the entire skeletal system adequately.

Studies confirm that oblique views of the thorax increase the chances of identifying acute rib fractures [87] and that lateral views of the vertebrae are essential to exclude spinal skeletal injury [83]. Repeat skeletal surveys at 10–14 days have been shown to confirm the identity of ambiguous findings and to identify additional features not seen on the initial survey, particularly rib and metaphyseal fractures, and to support an opinion regarding the age of a fracture [88, 89]. In the event that a 10–14 day gap creates difficulties in safeguarding the child, a radionuclide bone scan may identify further acute fractures not evident on the skeletal survey, although it is relatively insensitive for skull or metaphyseal fractures.

Precise dating of fractures cannot be achieved [90]. Experienced pediatric radiologists are often prepared to offer an opinion on the age of fractures in broad terms according to the radiological appearance of the extent of fracture healing, that is, less than 2 weeks old, 2–4 weeks, or greater than 6 weeks. Textbooks offer time intervals for the different stages of fracture healing based on the experience of radiologists; to date, however, these have not been validated in clinical practice [91, 92].

Differential Diagnosis of Skeletal Injury

Any comprehensive clinical and forensic assessment must exclude conditions such as accidental injury, birth trauma, infection, rickets, osteogenesis imperfecta, and metabolic bone disease of prematurity in their differential diagnosis. A comprehensive birth history, as well as family and nutritional history, is as important as detailed scrutiny of skeletal images for markers of these conditions [93].

Abusive Head Trauma

AHT is among the most serious forms of physical abuse. The clinical outcome for children with AHT is poor and considerably worse than for those children with non-AHT [94–96]. Studies quote mortality rates of 8% [95] to 30% [9] in infants with AHT, and up to a half the victims of AHT sustain persistent neurological impairment.

The estimated incidence of infants under the age of 1 year who are admitted to hospital is 20–24/100,000 year [9, 97]. This rises to 36/100,000 for infants under 6 months old [9]. In practice, this means that pediatricians in nonspecialized pediatric inpatient settings can expect to see a case infrequently, while pediatric intensive care and pediatric neurology units will do so on a regular basis. It is widely accepted that AHT arises from shaking, impact injuries, or a combination of both. One study reports that 2.6% of American parents admit to disciplining their infant children by shaking them, figures from less-developed countries are considerably higher [98]. It is therefore likely that hospitalized cases are only a proportion of a much wider issue.

The clinical presentation includes infants who present with unexplained traumatic brain injury or infants with other signs of physical abuse where intracranial injury is identified in the course of a full clinical investigation. Symptomatology can vary from a child who is dead at admission to children who present to hospital with a variety of neurological symptoms of varying degrees of impaired levels of consciousness, seizures, or apneic episodes, and some children presented with minor degrees of irritability or impaired feeding without overt neurological symptoms [9, 95].

Presenting History

One study [95] compared the presenting history of a group of children under the age of 3 with definite AHT with that of children with non-inflicted head trauma. They concluded that there is a high likelihood of abuse in children who have traumatic intracranial injury with no history of trauma or in children with persistent neurological impairment and a history of low impact fall (equivalent to falls of less than 3 ft). They also showed that an explanation of out of hospital cardiopulmonary resuscitation or a changing history or one where alternative traumatic explanations were offered was more common in cases of definite abuse. Low impact trauma was not specific for abuse in children without neurological impairment, consistent with the fact that low falls can cause skull fracture and rarely intracranial injury which is unlikely to be severe enough to cause neurological impairment. Late presentation to hospital and sibling involvement did not appear to be significant discriminatory features.

Clinical Features of Abusive Head Trauma

Ever since 1946 when Caffey [99] entitled his article "Multiple fractures of long bones of children suffering from subdural haematoma," it has been accepted that a number of features are often associated with AHT. Along with bruises and other cutaneous injuries these children may sustain different combinations of fractures, retinal hemorrhages, apnoeic episodes, and seizures more commonly than children with traumatic injury of a known accidental cause.

Retinal hemorrhages (RHs) are strongly associated with AHT. Studies have identified RHs in 70–80% of cases of confirmed AHT [100]. In contrast, they are seen in fewer than 10% of nonabusive head injuries. In the majority of cases of AHT, the hemorrhages are widespread throughout the retina, extending to the periphery. They are more often bilateral than unilateral, and are commonly found throughout all layers of the retina. When they are present after accidental head injury, the hemorrhages are predominantly few in number and located primarily at the posterior pole or around the optic disc. They are often unilateral. More wide spread hemorrhages are seen after crush injuries to the head and high falls. Numerous additional retinal features have also been reported in either condition; retinal schisis and perimacular folds have been reported in AHT and nonAHT following significant crush injuries or high fall (>35 ft). While there are features of RH that are undoubtedly strongly indicative of AHT, there is no pattern that is pathognomonic to either condition.

Studies show that pediatricians utilizing direct ophthalmoscopy are not skilled at identifying retinal abnormalities [101]. It is important therefore that any child with suspected AHT has a retinal examination performed by an ophthalmologist using indirect ophthalmology. Findings should be accurately recorded including the number, distribution, laterality, and layers of retina involved together with documentation of any additional ophthalmological findings. A RetCam image may provide a valuable record of the findings.

It should also be remembered that there are numerous other conditions associated with RHs in the age group at risk of AHT. These include some conditions that may have other features common to physical abuse such as coagulopathy disorders, birth-related retinal hemorrhages, metabolic disorders such as glutaric aciduria, homocystinuria, and osteogenesis imperfecta [102]. Other conditions such as cardio pulmonary resuscitation, apparent life threatening events (ALTE), epilepsy, and cough have been proposed to predispose to RH. However, there are very few published studies to help answer this question. RHs rarely occur after seizures and have not been reported in the literature in association with cardio pulmonary resuscitation, ALTE, or persistent coughing; however, published case series are small and inadequately powered to address the question with certainty.

Apnea and Seizures

Apnoeic episodes are increasingly recognized in association with AHT, which appears to coincide with the fact that hypoxic ischaemic injury is commonly seen on MRI images of these children [103]. Multiple factors are proposed to account for the apnea, such as respiratory insufficiency in an infant who is subjected to repeated traumatic events or damage to the respiratory control centers in the brainstem. Seizures are more strongly associated with children with AHT; prolonged seizure activity may exacerbate further hypoxic ischaemic damage to the brain through excitotoxic mechanisms or by inducing further respiratory insufficiency [103].

Fractures

Rib fractures and long bone fractures have been found to be associated with AHT. By comparison, skull fractures are associated with both abusive and non-AHT. The explanation proposed is likely to be the fact that most cases of non-AHT arise from falls or impact injuries that predispose to skull fractures whereas AHT may include shaking injuries with or without impact.

Neuro Radiological Features of AHT

Subdural hemorrhage (SDH) is significantly associated with AHT. AHT must be considered as a possible diagnosis in any child with an unexplained SDH. Subarachnoid hemorrhages are recorded equally in both abusive and non-AHT while extradural hemorrhage is significantly associated with non-AHT [104].

Specific characteristics of these SDHs in AHT are multiple bleeds [105] located in the inter-hemispheric fissure, over the convexities [106], or in the posterior fossa [105]. Intracerebral changes of AHT include cerebral oedema [106] and hypoxic ischemic injury [103].

The multiple SDHs seen in AHT have a variety of appearances on CT imaging. They are generally small, thin-film hemorrhages and may have different levels of attenuation. Hemorrhages that have a high attenuation, (high density or “white” appearance) on a CT are consistent with acute hemorrhages, and are described in the initial scans of both AHT and non-AHT. Hemorrhages with a low attenuation appearance on CT imaging are more commonly seen in AHT than non-AHT [105–108].

Low attenuation or hypo dense lesions where the appearance is darker are associated with resolving hemorrhages. However, the appearance of an SDH can be affected by a number of factors: different rates of resolution, low hemoglobin levels, mixing of CSF with the hemorrhage from rupture of arachnoid mater or villi, or coexisting primary or secondary coagulopathy.

An SDH can also have a mixed density appearance which has been described in both AHT and non-AHT [109, 110]. This finding may result from a number of processes: rapid clot formation and separation from unclotted blood or serum, benign extra-axial fluid collections of infancy with a superimposed acute SDH, two separate hemorrhagic events, or an acute admixture of high density blood and low density CSF.

The number of variables involved in the appearance of SDHs on CT therefore suggests that they should be described in terms of their radiological appearance rather than by terms such as acute and chronic that were used to describe high and low attenuation collections, respectively, in some early publications. Explanations for the appearance of the hemorrhages need careful consideration.

What Neuroimaging Should Be Performed When Abusive Head Trauma is Suspected

Current guidelines [85] suggest that CT is the first investigation of choice because of the widespread availability and technical ease of performing CT on a sick child on admission to hospital. However, MRI has added benefits and should be performed as soon as possible [111, 112]. In some centers with the appropriate expertise, MRI is increasingly accepted as the first line investigation. MRI is better at identifying small SDHs in areas obscure to CT imaging and is more sensitive to lesions within the brain parenchyma itself, which may provide prognostic information. MRI can help to differentiate subarachnoid hemorrhage or low attenuation subarachnoid fluid collections that may be consistent with a benign hygroma of infancy. There is increasing evidence that serial MRI may offer more support to dating the intracranial trauma utilizing signal analysis of resolving SDH on T1 and T2 weighted and FLAIR sequences [110, 112]. In a small child, it is also relatively easy to extend MRI to include the cranio cervical junction and spinal cord to exclude coexisting spinal injury which has been shown to be present in a number of cases.

Owing to the serious morbidity associated with AHT together with the varied and nonspecific nature of the condition. It is recommended that CT imaging is considered in any infant under the age of 12 months when physical abuse is suspected.

The differential diagnosis of AHT may include accidental head injury, coagulopathy disorders, and metabolic conditions such as glutaric aciduria and galactosaemia, birth related SDHs, cerebral infections, and benign extra axial fluid collections in infancy. These must all be considered within the diagnostic process.

Fabricated or Induced Illness

Fabricated or Induced Illness (FII) is a term used for child abuse where a child suffers harm (or is placed at risk of harm) as a result of fabrication (lying) or induction (causing) of illness by an adult carer. There is a spectrum of severity ranging from purely iatrogenic harm that arises when carers provide false information to doctors who then proceed to investigate or treat children unnecessarily, to severe physical abuse inflicted by carers who repeatedly present their children to medical services after smothering, poisoning, or other illness induction. These latter cases are often fatal whereas "fabrication only" cases are rarely fatal. All children exposed to this behavior are likely to suffer significant harm, both emotional harm arising from the unnecessary adoption of a "sick role" and physical harm which may be largely iatrogenic. Other forms of abuse may coexist and there are often very extensive difficulties with parent–child interaction that extend well beyond the medical interface.

FII replaced the previous term "Munchausen Syndrome by Proxy" (MSBP) in the United Kingdom in 2002 [113]. MSBP had widely been misinterpreted as a psychiatric condition in the carer "suffering from" MSBP. The term FII placed the focus back on to the child and the abuse it was suffering. Most observers suggest that there may be many pathways to fabrication that vary between perpetrators [114]. In the United States, the American Professional Society on the Abuse of Children (APSAC) has suggested separating the child's diagnosis (Pediatric Condition Falsification, PCF) from the diagnosis of the parent (DSM-IV Factitious Disorder by Proxy, FDP) and felt that both separate diagnoses should be confirmed before attributing a diagnosis of MSBP. In the United Kingdom, the focus tends to remain on the child and any supplementary diagnosis of the parent would depend on their discrete clinical features [115].

The core concept of FII is that the child does not have a medical condition that explains the symptoms described by the carer. The history is incongruous with the child's clinical features and investigation results and the overall presentation is perplexing for the physician.

The Wider "Spectrum" of FII Concerns

There are other situations where a child may be presented for medical attention with symptoms that sound serious, yet the child does not have a medical condition that explains their presentation. Table 5.1 provides a useful basis for a differential diagnosis of FII. It should be recognized that some exaggeration by carers is common and simply reflects the carer's anxiety about the child's condition and his/her need to gain the attention of the treating physician. All pediatricians should possess the skills to deal with this without recourse to child protection procedures. Persistent exaggeration and fabrication that has the potential to lead to harm to the child is a more serious situation that must be addressed. Of these examples, only type 3 would generally be recognized as FII by Pediatricians. This categorization is not exhaustive; for example, it does not deal with situations where carers are "malingering by proxy" [116] or attempting to defraud the state by lying about illness, nor does it encompass those situations where children actively fabricate their own illness.

While most FII cases are presented to pediatricians, some may be presented to child psychiatrists with unfounded complaints such as autism spectrum conditions,

Table 5.1 The range of situations where fabricated or induced illness (FII) concerns may arise [197]

Starting point: A child is presented for medical attention, possibly repeatedly, with symptoms or signs suggesting significant illness but an appropriate clinical assessment suggests that the child's "illness" is not adequately explained by any disease. The examples below illustrate the range of possible considerations

Example 1	Example 2	Example 3	Example 4	Example 5
Type of presentation				
Simple anxiety, lack of knowledge about illness, over interpretation of normal or trivial features of childhood. May in some cases be associated with depressive illness in carer	Child's symptoms are being misperceived, perpetuated, or reinforced by the carer's behavior. The carer may genuinely believe that child is ill or have fixed beliefs about illness	Parent actively promoting sick role by exaggeration, non-treatment of real problems, fabrication (lying), falsification of signs, and/or induction of illness (i.e., "True" FII) [a]	Parents suffering psychiatric illness, e.g., delusional disorder	Unrecognized genuine medical problem becomes apparent after initial concern about FII [b]
Underlying factors				
Carer's need to consult a doctor may be affected by other social stresses, mental health issues, or coping abilities of carer	"Illness" may be serving a function for carer, and subsequently for an older child too (secondary gains)	There may be a background history of frequent use of health services or apparent dependency on health care. Carer may have personality disorder or the child's "illness" may be serving a purpose for the carer	Usually not difficult to recognize	Possibility of "false positive" child abuse diagnosis must always be considered. Child's clinical progress should always be monitored in case a genuine illness has been missed
Insight				
Carer usually reassurable although likely to present again in future	Difficult to reassure; carer and professionals may not agree on cause of symptoms and/or the need to consult or investigate further	Not reassurable; carer's objectives are diametrically opposed to those of professionals	Carer lacks insight	Carer's "illness behavior" will usually be appropriate for the signs displayed by child, but the child protection intervention may have affected the carer's behavior

(continued)

Table 5.1 (continued)

Starting point: A child is presented for medical attention, possibly repeatedly, with symptoms or signs suggesting significant illness but an appropriate clinical assessment suggests that the child's "illness" is not adequately explained by any disease. The examples below illustrate the range of possible considerations

Example 1	Example 2	Example 3	Example 4	Example 5
Level of risk				
Seldom reaches threshold of significant harm	May be disabling: often some risk of significant harm, may be emotional or educational harm, or social isolation	High risk cases. Always some harm, often severe	May be risk of harm	Risk of harm due to inappropriate child protection process and delay in correct diagnosis
Iatrogenic harm				
Possible iatrogenic harm risk	Significant risk of iatrogenic harm	Very high risk of iatrogenic harm	Hopefully low risk of iatrogenic harm	See above
Management				
Discuss concerns openly with carer. Managed primarily by reassurance. Try to address carer's needs	Discussion with carers may need to be handled very sensitively. If in doubt, discuss with appropriate colleagues. Firm reassurance. Avoid iatrogenic harm. Multi-agency assessment may be needed to gain understanding of what underpins carer behavior (either "Child in Need" or "Child at risk" referrals may be indicated)	Local Safeguarding Children Procedures apply. Take immediate steps to reduce iatrogenic harm if possible. Do not disclose concerns to carers without first discussing the case within the Safeguarding procedures	Discuss with carers whether they feel that they have any mental health needs and how those might be addressed. Consider discussing with GP or other relevant professional (bearing in mind the constraints of patient confidentiality). Carer's mental health needs must be addressed. Child may be "Child in Need"	Consult widely with colleagues if a "false positive" child abuse diagnosis seems likely. If safeguarding procedures have already been activated, an immediate strategy meeting should be requested and the situation should be discussed with carers without delay

[a] Induced illness may include inflicted injuries intended to mimic a disease, but generally physical abuse where the perpetrator denies the cause of the injury would not be included

[b] Erroneous FII diagnosis has been described in the literature and this possibility must always be borne in mind. In one follow up study by the British Paediatric Surveillance Unit [135]. None of the 97 "MSBP" cases were subsequently found to have been due to misdiagnosed genuine disease (old terminology pertained at that time)

eating disorders, chronic fatigue, non-organic symptoms, or ADHD [117–121]. The carers involved may have complex reasons for presenting and may genuinely believe that their child has the condition, that is, different from the classical pediatric fabricating parent. They may have vested interests in obtaining a diagnosis; for example, they may need to feel that they are not responsible for their child's problems (or the problems of parent–child interaction), and they may want disability benefits for the child.

Some carers become convinced that their child has suffered abuse and may present repeatedly to child protection agencies requesting forensic assessment [122–125]. Some cases present in an education setting with carers who attempt to procure special educational support for a child who simply does not have the disability that is reported by the carers. In any of these situations, if there is concern that the child is at risk of harm and the situation cannot easily be resolved, then a child protection referral may be indicated. These situations may not fit comfortably under the label of FII as in many cases there is not good evidence that the carer is deliberately fabricating the child's illness.

Most perpetrators are mothers although a small number of cases involving fathers have been described [126–129]. No consistent psychopathology has been identified in FII perpetrators although some have personality disorder [130–132]. Certain characteristics have been observed in some cases, such as the following:

- Unusual calmness or knowledge of illnesses
- Parents who fit in contentedly with ward life or, paradoxically, actively obstruct medical care
- Factitious or somatoform disorder in the perpetrator
- Extensive fabrication in other areas of their lives
- Fabrication of illness in spouses or pets [133]
- A history of self harm,
- Complex obstetric histories that may be in part fabricated or self-induced problems [134]
- Alcohol or drug misuse
- Criminal activity
- Personality disorders including hysterical and borderline types [132]
- A personal history of being victims of child abuse or rape (which may not always be substantiated)
- A history of conduct disorder or eating disorder
- A very erratic employment record or interrupted training in a health related area
- Some engage in litigation, seek compensation, or allege harassment
- Some harass or complain about the doctor who made the diagnosis
- Financial mismanagement
- Marital and relationship difficulties, often well concealed

However, many of these features are present in carers who have not fabricated illness in their children and it would be wrong to use features such as these to support a diagnosis of FII. However, some of these are factors that must be considered in the wider assessment of risk to the child as part of the core social services assessment.

Epidemiology of FII

Studies give an estimated annual incidence of FII between 0.5 and 2/100,000 children under the age of 16 years. Figures vary according to study inclusion criteria [126, 135, 136]. The British Paediatric Surveillance Unit (BPSU) epidemiological study in United Kingdom in the early 1990s included new cases of FII, confirmed at Child Protection Case Conference or in Family Courts. There were 97 new cases identified over 2 years which suggests that a large teaching hospital will identify one or two new cases per year [126, 135]. There was no gender difference, the median age at onset was 20 months and 77% of the children were below 5 years of age. There were large unexplained variations in reported incidence between different regions in the United Kingdom.

In pediatric clinical practice, however, concerns about FII are frequently encountered because of the chronic nature of the presentations and the broad spectrum of the condition including "milder" cases that may not all require a formal child protection response. Large number of professionals may be involved in a single case. Watson et al. [137] surveyed Primary Care Teams and identified FII concerns in almost 1 in 1,000 children, most of whom had not been identified as being "at risk."

There have been a few reports of FII involving traditional healers and faith healers in developing countries [138, 139]; however, FII tends to be reported mainly from countries with well developed health services from secondary and tertiary care facilities where the clinicians can effectively join a *folie-a-deux* with the fabricating carer. The availability of investigative and treatment facilities and a defensive medical culture with a fear of missing a rare diagnosis and attracting criticism are probably important factors in its evolution. Doctors unwittingly become duped into harming the child by their tests and treatments, although the primary responsibility for the abuse clearly rests with the carers if they are deliberately deceiving the doctors.

Presenting Features

Certain medical conditions where the diagnosis rests mainly on history and there are no reliable signs or test results which would refute the diagnosis are more vulnerable to fabrication or induction than others. In confirmed FII cases, it is often apparent that when the child was first presented to doctors, the symptoms reported were vague and nonspecific. After seeing several doctors, the carer becomes more aware of the important clinical signs for the suspected condition and the history given by the carer becomes more precise and convincing. This is just one way in which doctors contribute inadvertently to the problem. Examples include fabricated seizures, apnea, allergies [140], asthma [141], vomiting, or diarrhea.

Some parents may extend the fabrication by falsifying physical signs. The commonest example is simulating blood loss, where the blood may be found to come from the carers themselves [126, 142]. It is very important that opportunities to analyze blood in these situations are not missed [143, 144]. Other examples are carers

Table 5.2 Indicators which should alert doctors to the possibility of fabricated or induced illness (FII) may be included [197]

Reported symptoms and observed signs are not explained by any medical condition from which the child may be suffering
Physical examination and results of investigations do not explain the reported symptoms or signs
Inexplicably poor response to prescribed medication or other treatment, or intolerance of treatment
Acute symptoms are exclusively observed by/in the presence of one carer, are not seen in the absence of that carer, and subside when the carer is not present
Reporting of new symptoms on resolution of previous problems or reporting symptoms in different children in sequence
Limitation of child's daily life and activities, beyond what is expected due to any known disorder from which the child is known to suffer, e.g., partial or no school attendance; limitation of activity; special aids
Objective evidence of fabrication, e.g., conflicting history of events from different observers; history of events which are biologically implausible (e.g., small infants with a history of very large blood losses who do not become anemic, or infants with large negative fluid balance who do not lose weight); test results such as toxicology studies or blood typing; covert video surveillance
Carers may express concern that they are under suspicion of causing FII, or relatives may raise concern that the carer may be causing the child's illness
Carers who seek multiple opinions inappropriately

who put glucose or albumin in urine samples, falsify blood glucose measurements or oxygen saturation readings, alter ward charts, tamper with laboratory specimens, obtain stomach or bowel contents from the child and substitute for other specimens, add water to the baby's nappy to falsify an excessive diuresis, spit in the child's ear, and so on. [145–147]. Falsified fever has become rare since the use of ear probe thermometers has replaced the old mercury thermometers.

The most extreme presentations merge with severe physical abuse and involve repeated smothering [148, 149] or poisoning [126], physically injuring the child to produce rashes [150, 151], administering noxious or caustic substances to various parts of the body [152–156], burning the child to mimic skin conditions [157], inserting needles into the abdominal cavity, gouging the child's ears, ligating body extremities, depriving the child of food [151], injecting feces into soft tissues or central lines to cause polymicrobial sepsis, and so on. [151, 158, 159]. These behaviors are far removed from the actions of any normal parent and are very ominous in terms of mortality and morbidity.

Table 5.2 lists indicators that may help to give an overall picture and prompt more detailed investigation of the possibility of FII. The medical presentations are varied. Table 5.3 summarizes the mode of presentation documented in the BPSU study.

Smothering cases present with apnea and cyanosis, with or without associated convulsions. ALTE are relatively common clinical presentations in early childhood and only a small percentage are due to abuse [160–162]. Repeated apnea occurring only in the presence of one carer, where the infant recovers rapidly without active treatment and has no features of any underlying disease, should alert suspicions of

Table 5.3 Presenting features in 97 "FII" cases from BPSU study [143]

Presenting feature	Fabrication cases	Fabrication with falsification cases	Illness induction cases	All cases
Fits	8	4	12	24
Apparent life threatening events (ALTE)	4	1	17	22
Drowsy, coma	0	1	12	13
Blood loss in vomit or rectally	2	8	3	13
Failure to thrive, feeding difficulty	1	1	9	11
Bowel disturbance	4	2	3	9
Asthma	6	0	3	9
Vomiting, gastro-esophageal reflux	0	2	6	8
Blood loss, haemoptysis	0	2	3	5
Skin lesions	0	0	4	4
Fabricated disability	3	0	0	3
False allegations of abuse	1	0	2	3
Blood in urine	0	2	1	3
False disclosure of accidental overdose	0	0	3	3

FII [163]. Fresh blood appearing at the nose or mouth in an infant with recurrent apnea should be regarded as ominous [164–166]. Smothered infants may also have diffuse shadowing on chest X-ray and altered blood indices, particularly a lymphocytosis [149]. Where smothering is confirmed, there is often a past history of a sibling death in suspicious circumstances [148].

Fabricated seizures are particularly difficult to diagnose and commonly mismanaged. There are many reasons for this; many normal children have odd "episodes" that could justifiably raise concern about seizures. Anxious parents may to some extent "refine" the history they provide to encourage doctors to take them seriously. Carers who have a propensity to exaggerate or fabricate their child's medical history will rapidly learn that this is fertile ground to exploit this tendency. Epilepsy is a clinical diagnosis and there is no diagnostic test that confirms or refutes the diagnosis. Electroencephalography (EEG) may be normal in children with epilepsy or abnormal in children who do not have epileptic seizures. EEG therefore has its place but should be interpreted with caution if the history provided by the carer cannot be relied upon. If in doubt, anti-epileptic medication should not be offered and further attempts should be made to secure reliable history and explore wider aspects of the family's presentation. Delay in starting treatment for genuine epilepsy in children is seldom prejudicial in any way [129, 151, 167–173].

Poisoning often presents with altered consciousness [174–178]. The commonest agents used to poison children in UK FII cases are anticonvulsants, maternal psychiatric drugs, drugs of abuse, paracetamol (acetaminophen), and household agents such as common salt or bleach [126]. Poisoning with insulin or hypoglycaemic drugs are also well recognized causes of hypoglycaemia. The latter will not show the characteristically high insulin:C-peptide ratio of exogenous insulin administration [179–181]. Toxicology studies should be requested if poisoning is suspected. Both blood and urine should be sent so that both qualitative and quantitative studies can be undertaken. Salt poisoning presents with hypernatraemia [182]. Where salt poisoning is suspected, urine sodium excretion should be carefully monitored as well as plasma sodium and osmolarity. Detailed guidelines have been produced by the Royal College of Paediatrics and Child Health in the United Kingdom [183]. Insulin poisoning is rare but serious and can be identified by the high blood insulin levels and lack of corresponding elevation of C-peptide [184–187].

Gastro-oesophageal reflux (GOR) also deserves particular mention. GOR in varying degrees is universal in infancy and there is considerable debate about the association with other problems such as apnea and whether in fact GOR is causal [161, 188]. The identification of GOR in the course of investigating recurrent apnea, persistent vomiting, or failure to thrive therefore should not prevent consideration of other possible diagnoses including FII, although FII probably accounts for only a very small proportion of persistent apnea or vomiting cases. The key, as usual, is careful history taking and clinical observation. Unfortunately, there have been many examples of cases where clinicians embarked on invasive interventions before the "penny dropped" and a diagnosis of FII was confirmed [126, 158, 187, 189–196].

Management of Suspected FII Cases

Detailed description of the clinical management of such cases and the ensuing child protection processes is contained in various other publications (notably the UK RCPCH guidelines of 2009) and is beyond the scope of this text. However, certain basic principles are worthy of emphasis (Table 5.4).

Covert Video Surveillance

This is a controversial area and is seldom needed if a comprehensive Health Chronology has been compiled and the possibility of FII considered in a multi-agency context. Covert video surveillance (CVS) would be indicated if there was no other viable way of safeguarding the welfare of the child. It is conducted by the police acting under the relevant legislation governing their investigatory powers (in the United Kingdom this is the Regulation of Investigatory Powers Act 2000) and should not be undertaken by health staff acting alone. Where it is felt that CVS may assist, it should be discussed in a strategy meeting attended by legal advisors

Table 5.4 Basic principles of management of FII

Where early concerns about FII arise, it is essential that iatrogenic harm is kept to a minimum
There are several available checklists of "warning signs" for FII that may be referred to at this stage and may be helpful
Taking a very detailed history of the child's condition from all adult carers is very important as important incongruities may arise. Some family members may already suspect FII and may volunteer this information
Any further tests or opinions should be directed at attempting to confirm or exclude the possibility of FII
All clinicians involved with the child should be made aware of the concerns
It is important that all clinicians keep an open mind and avoid dividing into discrete "camps" or assuming the role of advocate for the carer. The focus must be on the welfare of the child
Inflicting harmful investigations or treatments on a child in an attempt to exclude the presence of a rare disorder is inappropriate until concerns about FII have been resolved
The carer(s) should not be alerted to the concerns in the early stages as important opportunities to confirm a diagnosis may be lost, e.g., by forensic tests or covert video surveillance (CVS). The disclosure needs to be carefully planned to minimize the risks to the child and enable important evidence to be secured
The physician needs to keep an open mind and equal effort needs to be put into confirming genuine physical disease and FII
Information should be sought from other treating centers, bearing in mind the probability that the carers may have "shopped around" for various opinions (or to evade detection) and that perplexing problems are often referred to tertiary centers that may not be well placed to address a complex child protection concern
Sometimes, the most important "test" is to see if the child's symptoms resolve when the carer is absent. This may be difficult to arrange as an abusive carer will realize that his/her deception may be uncovered and will resist this plan, so statutory agencies may have to be involved
The threshold for making a child protection referral/report is a concern that the child may be at risk of significant harm. If that concern cannot be resolved rapidly without placing the child at further risk then a referral should be made
The initial strategy meeting, held without the carer's knowledge, is crucially important in defining a way forward and all relevant agencies need to be properly represented
The focus throughout has to be on the avoidance of harm to the child
The mental health needs of the carer should also be considered and appropriate supportive services offered after disclosure of the concerns
The absence of an identified mental health condition in the carer does not undermine the diagnosis of FII in any way and it is important that an adult psychiatrist does not assume the role of advocate for the carer within the child protection process
It is helpful if one physician (usually a pediatrician) assumes the role of responsible consultant and becomes the conduit for all medical information
A detailed medical chronology should be prepared and is likely to be invaluable in clarifying what, if any, medical conditions the child suffers from

and a senior police officer. The following circumstances might indicate that CVS would be helpful [149, 197].

- The cause of the child's illness is unexplained but FII abuse is suspected
- The prevailing evidence for child abuse is not considered strong enough to allow effective protection of the child or other children
- Other appropriate investigations have been undertaken and there is no realistic alternative investigation which may explain the child's illness

- Overt surveillance has been considered and not felt to be appropriate
- The child is having some type of "episode" of illness with a reasonable frequency (i.e., frequent enough that CVS is likely to capture an episode in a realistic timeframe)
- The "episodes" occur in hospital if the child is not closely supervised
- The location of the "event" is predictable, that is, the suspected abusive event is likely to be within the field of vision of CVS if it occurred
- The suspected act of abuse is something which is likely to be recognizable on CVS
- Appropriate resources and training can be made available in order to ensure that CVS can be undertaken efficiently and safely

If there is an agreement to proceed with CVS it would be sensible to involve a clinician with appropriate experience to oversee the medical contribution to the process.

Outcome of FII

Reported series include a large number of fatal cases, often around 10% or more [126, 129, 148, 189, 198]; however, there is likely to be considerable reporting bias. Other authors have reported significant long term morbidity, both physical and emotional, after FII abuse [135, 148, 158, 174, 187, 189, 199–201]. Davis et al. identified a high reabuse rate to victims or siblings who remained in the family setting. Bools et al. [202, 203] found considerable physical, emotional, and educational morbidity both in children who were removed into state care and in those who remained with their family. Berg and Jones [204] investigated the feasibility of reunification of children with the abusive carer after a period of inpatient psychiatric care. Twelve of thirteen children remained stable during the period of follow up while one suffered from further abuse. Three mothers apparently continued to exaggerate their child's health needs. Physical and developmental outcomes were generally good with six children showing mild developmental delays, three having ongoing physical problems, and two behavior problems. Libow highlighted longstanding problems in adult survivors of childhood FII [157]. Anybody wishing to read a harrowing account of a child's experience of FII should also read Julie Gregory's book *Sickened* [205]. Accounts like these remind us why we get involved in child protection.

References

1. Children Act 2004. http://www.opsi.gov.uk/acts/acts2004/ukpga_20040031_en_1
2. Child Abuse Prevention and Treatment Act Amendments of 1996. http://www.acf.hhs.gov/programs/cb/laws_policies/cblaws/capta/index.htm
3. Child Maltreatment Surveillance. http://www.cdc.gov/ncipc/dvp/CM_Surveillance.pdf

4. Gilbert R, Widom CS, Browne K et al (2009) Burden and consequences of child maltreatment in high-income countries. Lancet 373:68–81
5. Govindshenoy M, Spencer N (2007) Abuse of the disabled child: a systematic review of population-based studies. Child Care Health Dev 33:552–558
6. Sidebotham P, Heron J, Golding J; The ALSPAC Study Team (2002) Child maltreatment in the "Children of the Nineties:" deprivation, class, and social networks in a UK sample. Child Abuse Negl 26:1243–1259
7. Berger LM (2005) Income, family characteristics, and physical violence toward children. Child Abuse Negl 29:107–133
8. Child Maltreatment 2007. http://www.acf.hhs.gov/programs/cb/pubs/cm07/
9. Jayawant S, Rawlinson A, Gibbon F et al (1998) Subdural haemorrhages in infants: population based study. BMJ 317:1558–1561
10. Collins KA, Nichols CA (1999) A decade of pediatric homicide: a retrospective study at the Medical University of South Carolina. Am J Forensic Med Pathol 20:169–172
11. Behrman RE, Kliegman RM, Jenson HB (2000) Nelson textbook of pediatrics, 16th edn. W. B. Saunders, Philadelphia
12. Murty OP, Ming CJ, Ezani MA et al (2006) Physical injuries in fatal and non-fatal child abuse cases: a review of 16 years with hands on experience of 2 years in Malaysia. Int J Med Toxicol Legal Med 9:33–43
13. Trocme N, MacMillan H, Fallon B, De Marco R (2003) Nature and severity of physical harm caused by child abuse and neglect: results from the Canadian Incidence Study [see comment]. CMAJ 169:911–915
14. King WK, Kiesel EL, Simon HK (2006) Child abuse fatalities: are we missing opportunities for intervention? Pediatr Emerg Care 22:211–214
15. Sugar NF, Taylor JA, Feldman KW (1999) Bruises in infants and toddlers: those who don't cruise rarely bruise. Puget Sound Pediatric Research Network. Arch Pediatr Adolesc Med 153:399–403
16. Labbé J, Caouette G (2001) Recent skin injuries in normal children. Pediatrics 108:271–276
17. Dunstan FD, Guildea ZE, Kontos K et al (2002) A scoring system for bruise patterns: a tool for identifying abuse. Arch Dis Child 86:330–333
18. Atwal GS, Rutty GN, Carter N, Green MA (1998) Bruising in non-accidental head injured children; a retrospective study of the prevalence, distribution and pathological associations in 24 cases. Forensic Sci Int 96:215–230
19. Carpenter RF (1999) The prevalence and distribution of bruising in babies. Arch Dis Child 80:363–366
20. Chang L-T, Tsai M-C (2007) Craniofacial injuries from slip, trip, and fall accidents of children. J Trauma 63:70–74
21. Jessee SA (1995) Physical manifestations of child abuse to the head, face and mouth: a hospital survey. ASDC J Dent Child 62:245–249
22. Feldman KW (1992) Patterned abusive bruises of the buttocks and the pinnae. Pediatrics 90:633–636
23. Hanigan WC, Peterson RA, Njus G (1987) Tin ear syndrome: rotational acceleration in pediatric head injuries. Pediatrics 80:618–622
24. Wedgwood J (1990) Childhood bruising. Practitioner 234:598–601
25. Nayak K, Spencer N, Shenoy M et al (2006) How useful is the presence of petechiae in distinguishing non-accidental from accidental injury? Child Abuse Negl 30:549–555
26. Ellerstein NS (1979) The cutaneous manifestations of child abuse and neglect. Am J Dis Child 133:906–909
27. Brinkmann B, Püschel K, Mätzsch T (1979) Forensic dermatological aspects of the battered child syndrome. Aktuelle Derm 5:217–232

28. Polson CJ, Gee DJ et al (1985) Injuries: general features. In: Polson CJ, Gee DJ, Knight B (eds) The essentials of forensic medicine. Pergamon, Oxford, pp 91–147
29. Maguire S, Mann MK, Sibert J, Kemp A (2005) Can you age bruises accurately in children? Arch Dis Child 90:187–189
30. Munang LA, Leonard PA, Mok J (2002) Lack of agreement on colour description between clinicians examining childhood bruising. J Clin Forensic Med 9:171–174
31. Becker DB, Needleman HL, Kotelchuck M (1978) Child abuse and dentistry: orofacial trauma and its recognition by dentists. J Am Dent Assoc 97:24–28
32. Naidoo S (2000) A profile of the oro-facial injuries in child physical abuse at a children's hospital. Child Abuse Negl 24:521–534
33. Maguire SA, Hunter B, Hunter LM et al (2007) Diagnosing abuse: a systematic review of torn frenum and intra-oral injuries. Arch Dis Child 92:1113–1117
34. Cameron JM, Johnson HRM, Camps FE (1966) The battered child syndrome. Med Sci Law 6:2–21
35. Tate RJ (1971) Facial injuries associated with the battered child syndrome. Br J Oral Surg 9:41–45
36. Price EA, Rush LR, Perper JA, Bell MD (2000) Cardiopulmonary resuscitation-related injuries and homicidal blunt abdominal trauma in children. Am J Forensic Med Pathol 21:307–310
37. Torriani DD, Bonow ML, Fleischmann MD, Muller LT (2008) Traumatic intrusion of primary tooth: follow up until eruption of permanent successor tooth. Dent Traumatol 24:235–238
38. Cordner SM, Burke MP, Dodd MJ et al (2001) Issues in child homicides: 11 cases. Leg Med 3:95–103
39. Thackeray JD (2007) Frena tears and abusive head injury: a cautionary tale. Pediatr Emerg Care 23:735–737
40. AAPD; American Academy of Pediatrics Committee on Child Abuse and Neglect & American Academy of Pediatric Dentistry Ad Hoc Work Group on Child Abuse and Neglect (1999) Oral and dental aspects of child abuse and neglect. Pediatrics 104:348–350
41. Wright J, Thornton J (1983) Osteogenesis imperfecta with dentinogenesis imperfecta. A mistaken case of child abuse. Pediatr Dent 5:207–209
42. Carrotte PV (1990) An unusual case of child abuse. Br Dent J 168:444–445
43. Baker MD, Moore SE (1987) Human bites in children. A six-year experience. Am J Dis Child 141:1285–1290
44. Whittaker DK, MacDonald DG (1989) Bitemarks in flesh. In: Anonymous (eds) A colour atlas of forensic dentistry. Wolfe Medical Publications, London, p 108
45. Freeman AJ, Senn DR, Arendt DM (2005) Seven hundred seventy eight bite marks: analysis by anatomic location, victim and biter demographics, type of crime, and legal disposition. J Forensic Sci 50:1436–1443
46. Levine LJ (1984) Bite marks in child abuse. In: Sanger RG, Bross DC (eds) Clinical management of child abuse and neglect. Quintessence, Chicago, pp 53–59
47. Bernitz H, Owen JH, van Heerden WF, Solheim T (2008) An integrated technique for the analysis of skin bite marks. J Forensic Sci 53:194–198
48. BAFO (British Association of Forensic Odontology) (2001) Guidelines bitemark methodology. http://www.forensicdentistryonline.org/Forensic_pages_1/bitemarkguide.htm
49. Chester DL, Jose RM, Aldlyami E et al (2006) Non-accidental burns in children – are we neglecting neglect? Burns 32:222–228
50. Montrey JS, Barcia PJ (1985) Nonaccidental burns in child abuse. South Med J 78:1324–1326
51. Daria S, Sugar NF, Feldman KW et al (2004) Into hot water head first: distribution of intentional and unintentional immersion burns. Pediatr Emerg Care 20:302–310

52. Ojo P, Palmer J, Garvey R et al (2007) Pattern of burns in child abuse. Am Surg 73:253–255
53. Zaloga WF, Collins KA (2006) Pediatric homicides related to burn injury: a retrospective review at the Medical University of South Carolina. J Forensic Sci 51:396–399
54. Maguire S, Moynihan S, Mann M et al (2008) A systematic review of the features that indicate intentional scalds in children. Burns 34:1072–1081
55. Yeoh C, Nixon JW, Dickson W et al (1994) Patterns of scald injuries. Arch Dis Child 71:156–158
56. Caniano DA, Beaver BL, Boles ET (1986) Child abuse: an update on surgical management in 256 cases. Ann Surg 203:219–224
57. Lowell G, Quinlan K, Gottlieb LJ (2008) Preventing unintentional scald burns: moving beyond tap water. Pediatrics 122:799–804
58. Dressler DP, Hozid JL (2001) Thermal injury and child abuse: the medical evidence dilemma. J Burn Care Rehabil 22:180–185
59. Feldman KW, Schaller RT, Feldman JA, McMillon M (1998) Tap water scald burns in children. Inj Prev 4:238–242
60. Allasio D, Fischer H (2005) Immersion scald burns and the ability of young children to climb into a bathtub. Pediatrics 115:1419–1421
61. Titus MO, Baxter AL, Starling SP (2003) Accidental scald burns in sinks. Pediatrics 111:e191–e194
62. Hicks RA, Stolfi A (2007) Skeletal surveys in children with burns caused by child abuse. Pediatr Emerg Care 23:308–313
63. Grellner W, Metzner G (1995) Kindesmißhandlung durch thermische Gewalt: Abgrenzung und Rekonstruktion [Child abuse caused by thermal violence – determination and reconstruction]. Arch Kriminol 195:38–46
64. Baron S, Moss C (2003) Images in paediatrics: caustic burn caused by potassium permanganate. Arch Dis Child 88:96
65. Alexander RC, Surrell JA, Cohle SD (1987) Microwave oven burns to children: an unusual manifestation of child abuse. Pediatrics 79:255–260
66. Wilson Jones N, Wong P, Potokar T (2008) Electric hair straightener burns an epidemiological and thermodynamic study. Burns 34:521–524
67. Hobbs CJ, Wynne JM (1990) The sexually abused battered child. Arch Dis Child 65:423–427
68. Badger K, Anderson L, Kagan RJ (2008) Attention deficit-hyperactivity disorder in children with burn injuries. J Burn Care Res 29:724–729
69. Barnes PM, Norton CM, Dunstan FD et al (2005) Abdominal injury due to child abuse. Lancet 366:234–235
70. Gaines BA, Shultz BS, Morrison K, Ford HR (2004) Duodenal injuries in children: beware of child abuse. J Pediatr Surg 39:600–602
71. Lindberg D, Makoroff K, Harper N et al (2009) Utility of hepatic transaminases to recognize abuse in children. Pediatrics 124:509–516
72. Wood J, Rubin DM, Nance ML, Christian CW (2005) Distinguishing inflicted versus accidental abdominal injuries in young children. J Trauma 59:1203–1208
73. Worlock P, Stower M, Barbor P (1986) Patterns of fractures in accidental and non-accidental injury in children: a comparative study. BMJ 293:100–102
74. Leventhal JM, Thomas SA, Rosenfield NS, Markowitz RI (1993) Fractures in young children. Distinguishing child abuse from unintentional injuries. Am J Dis Child 147:87–92
75. Kemp AM, Dunstan F, Harrison S et al (2008) Patterns of skeletal fractures in child abuse: a systematic review. BMJ 337:a1518
76. Pandya NK, Baldwin K, Wolfgruber H et al (2009) Child abuse and orthopaedic injury patterns: analysis at a level I pediatric trauma center. J Pediatr Orthop 29:618–625

77. Farnsworth CL, Silva PD, Mubarak SJ (1998) Etiology of supracondylar humerus fractures. J Pediatr Orthop 18:38–42
78. Dalton HJ, Slovis T, Helfer RE et al (1990) Undiagnosed abuse in children younger than 3 years with femoral fracture. Am J Dis Child 144:875–878
79. Anderson WA (1982) The significance of femoral fractures in children. Ann Emerg Med 11:174–177
80. Beals RK, Tufts E (1983) Fractured femur in infancy: the role of child abuse. J Pediatr Orthop 3:583–586
81. Altman DH, Smith RL (1960) Unrecognised trauma in infants and children. J Bone Joint Surg 42:407–413
82. Grayev AM, Boal DKB, Wallach DM, Segal LS (2001) Metaphyseal fractures mimicking abuse during treatment for clubfoot. Pediatr Radiol 31:559–563
83. Kemp A, Joshi A, Mann M et al (2010) What are the clinical and radiological characteristics of spinal injuries from physical abuse: a systematic review. Arch Dis Child 95(5):355–360
84. Merten DF, Radlowski MA, Leonidas JC (1983) The abused child: a radiological reappraisal. Radiology 146:377–381
85. The Royal College of Radiologists and Royal College of Paediatrics and Child Health (2008) Standards for radiological investigations of suspected non-accidental injury. The Royal College of Radiologists, London
86. ACR revised standards for SS in children. http://www.acr.org
87. Hansen KK, Prince JS, Nixon GW (2008) Oblique chest views as a routine part of skeletal surveys performed for possible physical abuse-is this practice worthwhile? Child Abuse Negl 32:155–159
88. Kleinman PK, Nimkin K, Spevak MR et al (1996) Follow-up skeletal surveys in suspected child abuse. Am J Roentgenol 167:893–896
89. Zimmerman S, Makoroff K, Care M et al (2005) Utility of follow-up skeletal surveys in suspected child physical abuse evaluations. Child Abuse Negl 29:1075–1083
90. Prosser I, Maguire S, Harrison SK et al (2005) How old is this fracture? Radiologic dating of fractures in children: a systematic review. Am J Roentgenol 184:1282–1286
91. Kleinman PK (1998) Diagnostic imaging of child abuse, 2nd edn. Mosby, St. Louis
92. Offiah AC, Hall CM, Fairhurst J (2009) Radiological atlas of child abuse. Radcliffe Publishing, Oxford
93. Bishop N, Sprigg A, Dalton A (2007) Unexplained fractures in infancy: looking for fragile bones. Arch Dis Child 92:251–256
94. Ettaro L, Berger RP, Songer T (2004) Abusive head trauma in young children: characteristics and medical charges in a hospitalized population. Child Abuse Negl 28:1099–1111
95. Hettler J, Greenes DS (2003) Can the initial history predict whether a child with a head injury has been abused? Pediatrics 111:602–607
96. Vinchon M, Defoort-Dhellemmes S, Desurmont M, Dhellemmes P (2005) Accidental and nonaccidental head injuries in infants: a prospective study. J Neurosurg 102:380–384
97. Hobbs C, Childs AM, Wynne J et al (2005) Subdural haematoma and effusion in infancy: an epidemiological study. Arch Dis Child 90:952–955
98. Runyan DK (2008) The challenges of assessing the incidence of inflicted traumatic brain injury: a world perspective. Am J Prev Med 34:112–115
99. Caffey J (1946) Multiple fractures in the long bones of infants suffering from chronic subdural haematoma. Am J Roentgenol 56:163–173
100. Maguire SA, Watts PO, Taylor RH, Shaw AD, Holden S, Watkins WJ, Mann MK, Tempest V, Kemp AM (in press) Retinal hemorrhages and related findings in abusive and non-abusive head trauma: a systematic review

101. Morad Y, Kim YM, Mian M et al (2003) Nonophthalmologist accuracy in diagnosing retinal hemorrhages in the shaken baby syndrome. J Pediatr 142:431–434
102. Maguire SA, Moynihan S, Bunting HJ, Watts PO, Adams GG, Mann MK, Lumb RC, Kemp AM (in press) A systematic review of the differential diagnosis of retinal hemorrhages in children
103. Ichord RN, Naim M, Pollock AN et al (2007) Hypoxic-ischemic injury complicates inflicted and accidental traumatic brain injury in young children: the role of diffusion-weighted imaging. J Neurotrauma 24:106–118
104. Bechtel K, Stoessel K, Leventhal JM et al (2004) Characteristics that distinguish accidental from abusive injury in hospitalized young children with head trauma. Pediatrics 114:165–168
105. Ewing-Cobbs L, Prasad M, Kramer L et al (2000) Acute neuroradiologic findings in young children with inflicted or noninflicted traumatic brain injury. Childs Nerv Syst 16:25–34
106. Wells RG, Vetter C, Laud P (2002) Intracranial hemorrhage in children younger than 3 years: prediction of intent. Arch Pediatr Adolesc Med 156:252–257
107. Feldman KW, Bethel R, Shugerman RP et al (2001) The cause of infant and toddler subdural hemorrhage: a prospective study. Pediatrics 108:636–646
108. Kelly P, Hayes I (2004) Infantile subdural haematoma in Auckland, New Zealand: 1988–1998. N Z Med J 117:U1047
109. Tung GA, Kumar M, Richardson RC et al (2006) Comparison of accidental and nonaccidental traumatic head injury in children on noncontrast computed tomography. Pediatrics 118:626–633
110. Vinchon M, Noulé N, Tchofo PJ et al (2004) Imaging of head injuries in infants: temporal correlates and forensic implications for the diagnosis of child abuse. J Neurosurg 101:44–52
111. Kemp AM, Rajaram S, Mann M et al (2009) What neuroimaging should be performed in children in whom inflicted brain injury (iBI) is suspected? A systematic review. Clin Radiol 64:473–483
112. Vezina G (2009) Assessment of the nature and age of subdural collections in nonaccidental head injury with CT and MRI. Pediatr Radiol 39:586–590
113. Royal College of Paediatrics and Child Health (2002) Fabricated or induced illness by carers. Royal College of Paediatrics and Child Health, London
114. Adshead G, Bluglass K (2005) Attachment representations in mothers with abnormal illness behaviour by proxy. Br J Psychiatry 187:328–333
115. Galvin HK, Newton AW, Vandeven AM (2005) Update on Munchausen syndrome by proxy. Curr Opin Pediatr 17:252–257
116. Feldman MD (2004) Munchausen by proxy and malingering by proxy. Psychosomatics 45:365–366
117. Fisher GC, Mitchell I, Murdoch D (1993) Munchausen's syndrome by proxy. The question of psychiatric illness in a child. Br J Psychiatry 162:701–703
118. Katz RL, Mazer C, Litt IF (1985) Anorexia nervosa by proxy. J Pediatr 107:247–248
119. MacDonald TM (1989) Myalgic encephalomyelitis by proxy. Br Med J 299:1030–1031
120. Schreier HA (1997) Factitious presentation of psychiatric disorder: when is it Munchausen by proxy? Child Adolesc Ment Health 2:108–115
121. Scourfield J (1995) Anorexia by proxy: are the children of anorexic mothers an at-risk group? Int J Eat Disord 18:371–374
122. Barker LH, Howell RJ (1994) Munchausen syndrome by proxy in false allegations of child sexual abuse: legal implications. Bull Am Acad Psychiatry Law 22:499–510
123. Marcus A, Ammermann C, Klein M, Schmidt MH (1995) Munchausen syndrome by proxy and factitious illness: symptomatology, parent-child interaction, and psychopathology of the parents. Eur Child Adolesc Psychiatry 4:229–236

124. Meadow R (1993) False allegations of abuse and Munchausen syndrome by proxy. Arch Dis Child 68:444–447
125. Schreier HA (1996) Repeated false allegations of sexual abuse presenting to sheriffs: when is it Munchausen by Proxy? Child Abuse Negl 20:985–991
126. McClure RJ, Davis PM, Meadow SR, Sibert JR (1996) Epidemiology of Munchausen syndrome by proxy, non-accidental poisoning, and non-accidental suffocation. Arch Dis Child 75:57–61
127. Meadow R (1998) Munchausen syndrome by proxy abuse perpetrated by men. Arch Dis Child 78:210–216
128. Parnell TF, Day DO (1997) Munchausen by proxy syndrome: misunderstood child abuse. Sage, Thousand Oaks
129. Rosenberg DA (1987) Web of deceit: a literature review of Munchausen syndrome by proxy. Child Abuse Negl 11:547–563
130. Bluglass K (1993) 'Factitious' illness or 'Munchausen by proxy'. Curr Pediatr 3:81–85
131. Bools C (1996) Factitious illness by proxy. Munchausen syndrome by proxy. Br J Psychiatry 169:268–275
132. Bools C, Neale B, Meadow R (1994) Munchausen syndrome by proxy: a study of psychopathology. Child Abuse Negl 18:773–788
133. Buchta R (1988) Deliberate intoxication of young children and pets with drugs: a survey of an adolescent population in a private practice. Am J Dis Child 142:701–702
134. Feldman MD, Hamilton JC (2006) Serial factitious disorder and Munchausen by proxy in pregnancy. Int J Clin Pract 60:1675–1678
135. Davis P, McClure RJ, Rolfe K et al (1998) Procedures, placement, and risks of further abuse after Munchausen syndrome by proxy, non-accidental poisoning, and non-accidental suffocation. Arch Dis Child 78:217–221
136. Denny SJ, Grant CC, Pinnock R (2001) Epidemiology of Munchausen syndrome by proxy in New Zealand. J Paediatr Child Health 37:240–243
137. Eminson DM, Postlethwaite RJ (2000) Munchausen syndrome by proxy abuse: a practical approach. Butterworth Heinemann, Oxford
138. Ifere OA, Yakubu AM, Aikhionbare HA et al (1993) Munchausen syndrome by proxy: an experience from Nigeria. Ann Trop Paediatr 13:281–284
139. Oyelami OA, Alhaj AM, Airede IK (1994) Münchausen syndrome by proxy – a case report and review of literature. Cent Afr J Med 40:222–226
140. Warner JO, Hathaway MJ (1984) Allergic form of Meadow's syndrome (Munchausen by proxy). Arch Dis Child 59:151–156
141. Godding V, Kruth M (1991) Compliance with treatment in asthma and Munchausen syndrome by proxy. Arch Dis Child 66:956–960
142. Meadow R (1982) Munchausen syndrome by proxy. Arch Dis Child 57:92–98
143. Davis P (2000) The Cardiff Leeds study of alleged Munchausen syndrome by proxy, non accidental poisoning and non-accidental suffocation. Welsh Pediatr J 13:32–41
144. Wenk RE (2003) Molecular evidence of Munchausen syndrome by proxy. Arch Pathol Lab Med 127:36–37
145. Bennett AM, Bennett SM, Prinsley PR, Wickstead M (2005) Spitting in the ear: a falsified disease using video evidence. J Laryngol Otol 119:926–927
146. McSweeney JJ, Hoffman RP (1991) Munchausen's syndrome by proxy mistaken for IDDM. Diabetes Care 14:928–929
147. Ulinski T, Lhopital C, Cloppet H et al (2004) Munchausen syndrome by proxy with massive proteinuria and gastrointestinal hemorrhage. Pediatr Nephrol 19:798–800

148. Meadow R (1990) Suffocation, recurrent apnea, and sudden infant death. J Pediatr 117:351–357
149. Southall DP, Plunkett MC, Banks MW et al (1997) Covert video recordings of life-threatening child abuse: lessons for child protection. Pediatrics 100:735–760
150. Clark GD, Key JD, Rutherford P, Bithoney WG (1984) Munchausen's syndrome by proxy (child abuse) presenting as apparent autoerythrocyte sensitization syndrome: an unusual presentation of Polle syndrome. Pediatrics 74:1100–1102
151. Gray J, Bentovim A (1996) Illness induction syndrome: paper 1 – A series of 41 children from 37 families identified at The Great Ormond Street Hospital for Children NHS Trust. Child Abuse Negl 20:655–673
152. Baskin DE, Stein F, Coats DK, Paysse EA (2003) Recurrent conjunctivitis as a presentation of Munchausen syndrome by proxy. Ophthalmology 110:1582–1584
153. Clin B, Ferrant O, Dupont C, Papin F (2009) Recurrent caustic esophagitis: a clinical form of Münchausen syndrome by proxy. Child Abuse Negl 33:293–295
154. Friedman EM (1987) Caustic ingestions and foreign body aspirations: an overlooked form of child abuse. Ann Otol Rhinol Laryngol 96:709–712
155. Postlethwaite RJ (2010) Caustic ingestion as a manifestation of fabricated and induced illness (Munchausen syndrome by proxy). Child Abuse Negl 34:471
156. Tamay Z, Akcay A, Kilic G et al (2007) Corrosive poisoning mimicking cicatricial pemphigoid: Munchausen by proxy. Child Care Health Dev 33:496–499
157. Libow JA (1995) Munchausen by proxy victims in adulthood: a first look. Child Abuse Negl 19:1131–1142
158. Lacey SR, Cooper C, Runyan DK, Azizkhan RG (1993) Munchausen syndrome by proxy: patterns of presentation to pediatric surgeons. J Pediatr Surg 28:827–832
159. Vennemann B, Perdekamp MG, Weinmann W et al (2006) A case of Munchausen syndrome by proxy with subsequent suicide of the mother. Forensic Sci Int 158:195–199
160. Kiechl-Kohlendorfer U, Hof D, Peglow UP et al (2005) Epidemiology of apparent life threatening events. Arch Dis Child 90:297–300
161. McGovern MC, Smith MB (2004) Causes of apparent life threatening events in infants: a systematic review. Arch Dis Child 89:1043–1048
162. Rahilly PM (1991) The pneumographic and medical investigation of infants suffering apparent life threatening episodes. J Paediatr Child Health 27:349–353
163. British Paediatric Association (1994) Evaluation of suspected imposed upper airway obstruction: report of a Working Party. British Paediatric Association, London
164. Krous HF, Nadeau JM, Byard RW, Blackbourne BD (2001) Oronasal blood in sudden infant death. Am J Forensic Med Pathol 22:346–351
165. McIntosh N, Mok JY, Margerison A (2007) Epidemiology of oronasal hemorrhage in the first 2 years of life: implications for child protection. Pediatrics 120:1074–1078
166. Walton LJ, Davies FC (2010) Nasal bleeding and non-accidental injury in an infant. Arch Dis Child 95:53–54
167. Ackerman NB Jr, Strobel CT (1981) Polle syndrome: chronic diarrhea in Munchausen's child. Gastroenterology 81:1140–1142
168. Baldwin MA (1994) Munchausen syndrome by proxy: neurological manifestations. J Neurosci Nurs 26:18–23
169. Barber MA, Davis PM (2002) Fits, faints, or fatal fantasy? Fabricated seizures and child abuse. Arch Dis Child 86:230–233
170. Martinović Z (1995) Fictitious epilepsy in Munchausen syndrome by proxy: family psychodynamics. Seizure 4:129–134

171. Meadow R (1982) Munchausen syndrome by proxy and pseudo-epilepsy. Arch Dis Child 57:811–812
172. Meadow R (1984) Fictitious epilepsy. Lancet 2:25–28
173. Meadow R (1991) Neurological and developmental variants of Munchausen syndrome by proxy. Dev Med Child Neurol 33:270–272
174. Dine MS, McGovern ME (1982) Intentional poisoning of children – an overlooked category of child abuse: report of seven cases and review of the literature. Pediatrics 70:32–35
175. Fischler RS (1983) Poisoning: a syndrome of child abuse. Am Fam Physician 28:103–108
176. Meadow R (1989) ABC of child abuse. Poisoning. Br Med J 298:1445–1446
177. Rogers D, Tripp J, Bentovim A et al (1976) Non-accidental poisoning: an extended syndrome of child abuse. Br Med J 1:793–796
178. Shnaps Y, Frand M, Rotem Y, Tirosh M (1981) The chemically abused child. Pediatrics 68:119–121
179. Giurgea I, Ulinski T, Touati G et al (2005) Factitious hyperinsulinism leading to pancreatectomy: severe forms of Munchausen syndrome by proxy. Pediatrics 116:e145–e148
180. Green RP, Hollander AS, Thevis M et al (2010) Detection of surreptitious administration of analog insulin to an 8-week-old infant. Pediatrics 125:e1236–e1240
181. Marks V (2009) Murder by insulin: suspected, purported and proven-a review. Drug Test Anal 1:162–176
182. Meadow R (1993) Non-accidental salt poisoning. Arch Dis Child 68:448–452
183. Royal College of Paediatrics and Child Health (2009) The differential diagnosis of hypernatraemia in children, with particular reference to salt poisoning. An evidence-based guideline. Royal College of Paediatrics and Child Health, London
184. Bauman WA, Yalow RS (1981) Child abuse: parenteral insulin administration. J Pediatr 99:588–591
185. Dershewitz R, Vestal B, Maclaren NK, Cornblath M (1976) Transient hepatomegaly and hypoglycemia. A consequence of malicious insulin administration. Am J Dis Child 130:998–999
186. Mayefsky JH, Sarnaik AP, Postellon DC (1982) Factitious hypoglycemia. Pediatrics 69:804–805
187. Zitelli BJ, Seltman MF, Shannon RM (1987) Munchausen's syndrome by proxy and its professional participants. Am J Dis Child 141:1099–1102
188. Amin RS (2000) Gastroesophageal reflux and infant apnea. J Pediatr 137:298–300
189. Alexander R, Smith W, Stevenson R (1990) Serial Munchausen syndrome by proxy. Pediatrics 86:581–585
190. Baron HI, Beck DC, Vargas JH, Ament ME (1995) Overinterpretation of gastroduodenal motility studies: two cases involving Munchausen syndrome by proxy. J Pediatr 126:397–400
191. Colletti RB, Wasserman RC (1989) Recurrent infantile vomiting due to intentional ipecac poisoning. J Pediatr Gastroenterol Nutr 8:394–396
192. Goss PW, McDougall PN (1992) Munchausen syndrome by proxy – a cause of preterm delivery. Med J Aust 157:814–817
193. Klebes C, Fay S (1995) Munchausen syndrome by proxy: a review, case study, and nursing implications. J Pediatr Nurs 10:93–98
194. Kosmach B, Tarbell S, Reyes J, Todo S (1996) "Munchausen by proxy" syndrome in a small bowel transplant recipient. Transplant Proc 28:2790–2791
195. Schreier HA, Libow JA (1994) Munchausen by proxy syndrome: a modern pediatric challenge. J Pediatr 125:110–115
196. Turk LJ, Hanrahan KM, Weber ER (1990) Munchausen syndrome by proxy: a nursing overview. Issues Compr Pediatr Nurs 13:279–288
197. Royal College of Paediatrics and Child Health (2009) Fabricated or induced illness by carers (FII): a practical guide for paediatricians. Royal College of Paediatrics and Child Health, London
198. Samuels MP, Southall DP (1992) Munchausen syndrome by proxy. Br J Hosp Med 47:759–762

199. McGuire TL, Feldman KW (1989) Psychologic morbidity of children subjected to Munchausen syndrome by proxy. Pediatrics 83:289–292
200. Porter GE, Heitsch GM, Miller MD (1994) Munchausen syndrome by proxy: unusual manifestations and disturbing sequelae. Child Abuse Negl 18:789–794
201. Saulsbury FT, Chobanian MC, Wilson WG (1984) Child abuse: parenteral hydrocarbon administration. Pediatrics 73:719–722
202. Bools CN, Neale BA, Meadow SR (1993) Follow up of victims of fabricated illness (Munchausen syndrome by proxy). Arch Dis Child 69:625–630
203. Bools CN, Neale BA, Meadow SR (1992) Co-morbidity associated with fabricated illness (Munchausen syndrome by proxy). Arch Dis Child 67:77–79
204. Berg B, Jones D (1999) Outcome of psychiatric intervention in factitious illness by proxy (Munchausen's syndrome by proxy). Arch Dis Child 81:465–472
205. Gregory J (2004) Sickened. The true story of a lost childhood. Bantam, Sydney

Chapter 6
Chemical Crowd Control Agents

Steven B. Karch

Introduction

Chemical restraint is used in many settings: for controlling violent criminals or agitated patients, to disperse crowds (crowd control agents), or to limit access to specific areas. These agents have also been used by criminals as weapons in the commission of rape, robbery, and murder. The possibilities for the abuse of these agents are really quite vast and should always be considered in any forensic investigation. The situation is complicated by the fact that new agents are introduced regularly, and they may not always produce familiar or expected symptoms.

The effectiveness of any crowd control agent depends on the users' ability to delivery an adequate amount of the agent to the appropriate area of the body. Clearly, the application of capsicum to the back is not going to deter anyone. Therefore temperature, wind conditions, mode of delivery, formulation, and potential barriers such as clothing, masks, eye protectors, and the ability to decontaminate are all factors that inject variability, making responses unpredictable. Probably, the biggest hurdle in the use of capsicum and other containerized chemicals is attempting to deploy them in confined spaces. It is not uncommon for officers themselves to be exposed to the chemical agent while in the process of making an arrest.

There was once considerable debate concerning the use of chemical agents for crowd control, but both the debate and the necessity for the use of these agents seem to be subsiding. A study published in 2010 correlated the means used and outcome for all prisoners arrested in the city of Seattle in 2006 [1]. The authors reported that capsicum and other chemical agents were used in less than 5% of all arrests made during the year 2006. Since the last printing of these book, a new chemical agent has been added to the list (sufentinil) bringing to four the total number now known to be

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used: capsaicin oleum (pepper spray, PS or OC), chloracetothenon (mace or CN), and chlorobenzylidene (tear gas or CS). Some might argue that the addition of the TASER brings the group to five. Technically, neither TASERs nor sufentinil can be considered chemical incapacitating agents, but they are used for the same purpose and with relatively the same risk. They will be discussed in some detail below.

All of these agents offer the potential for great misuse [2, 3]. In a reported incident that occurred in the United States, law enforcement officers applied oleum capsicum liquid via a cotton-tipped applicator directly to the periorbital area of protesters who refused to disperse [4]. Litigation was the predictable result and so was the court verdict; a unanimous federal jury ruling that officers had used excessive force, a clear violation of the prisoner's Fourth Amendment rights; for British readers, The Fourth Amendment to the United States Constitution is the part of the U.S. Bill of Rights which guards against unreasonable searches and seizures. It specifically also requires search and arrest warrants be judicially sanctioned and supported by probable cause. It was adopted as a response to the abuse of the writ of assistance, which is a type of general search warrant. Such writs had their origin in the American Revolution.

When used appropriately, crowd control agents have a demonstrated high safety margin and generally do no permanent harm. The effect of less-lethal weapons (conductive energy devices or CEDs) and oleoresin capsicum (OC) spray, on the prevalence and incidence of injuries to police officers and civilians in encounters involving the use of force, was recently reviewed in a very large study. Data from 12 police departments that maintained adequate documentation regarding injuries to officers and civilians (24,380 cases) were reviewed. It was determined that odds of injury to civilians and officers were significantly lower when police used CED weapons, even after controlling for differences in case attributes and departmental policies restricting use of these weapons. Declines in the number of injuries ranged from 25 to 62%, and the authors of the study concluded that arrest-related injuries could be reduced dramatically when "less-lethal weapons in lieu of physical force" were employed [5].

In the past, there had been some debate about the safety of the delivery vehicles, particularly methyl isobutyl ketone (MIBK), and a study published in 2004 tends to reinforce these concerns. It demonstrated that dermatitis and blisters were more frequently reported after exposure to the type of capsicum spray employed by police than in individuals exposed to civilian formulation; most of the individuals presenting at casualty wards actually did require treatment with the police formulation, some with symptoms that persisted for a significant time afterward. The authors of this study concluded that the formulation of CS (*o*-chlorobenzylidine malononitrile) with MIBK (methyl isobutyl ketone), the formula used by the police, is more harmful that had been previously assumed. Given the evidence, it seems appropriate that use of this capsicum formulation be reviewed, especially because the side effects last so long. Less-concentrated formulations may reduce the severity or persistence of the adverse effects.

No discussion of chemical crowd control agents would be complete without at least some acknowledgment of a much more lethal method of control, one that is effective, potent, and often deadly. On October 22, 2002, Russian Special Forces used a vaporized synthetic narcotic called sufentanil (which is approximately 10 times the strength of fentanyl, itself 100 times the strength of morphine). Vaporized sufentanil was pumped through the air-handling equipment of a concert hall where Chechen terrorists were holding more than 100 innocent victims. The plan, as best as can be determined, was to disable the terrorists by exposure to sufentanyl, while, at the same time, administering Narcan antedote to the prisoners. Something obviously went wrong, as most of the captives died. Still, at least in theory, there is something to be said for the method, particularly in cases where only one individual needs to be sedated and treated. An individual suffering from excited delirium would be a perfect example.

Clinical Features and Treatment

The three principle chemical restraint compounds used by law enforcement are capsaicin oleum, chloracetothenon, and chlorobenzylidene. These agents are available in varying concentrations and in multiple delivery vehicles, including aerosols, foams, and particulate form. Each of the formulations requires the use of special dispersal devices. Some of these are listed in Table 6.1. All of these agents share common mechanisms. Collectively known as the "tear gas agents," they all interact with the TRPA1 receptor family. These receptors belong to the transient receptor potential (TRP) family of cation-selective channels that convert mechanical, thermal, and pain-related inflammatory signals, such as those that result from the application of "tear gas" agents into transmissible pain nerve signals [6].

The clinical effects of all these agents are short lived. The three commonly used chemical agents all produce lacrimation, ocular irritation and pain, dermal irritation, blepharospasm, conjunctivitis, transient impairment of vision, and mild-to-moderate respiratory distress [7–9]. As a group, each of these agents produces mildly toxic effects. CN is the most potent lacrimator and, at high concentrations, can cause corneal epithelial damage and chemosis. Use of CN has accounted for at least five deaths, all secondary to drug-induced pulmonary injury and/or asphyxia. CS is a 10-times more potent lacrimator than CN, but with less systemic toxicity. CR is the most potent lacrimator with the least systemic toxicity and is highly stable. CN, CS, and CR cause almost instant pain in the eyes, excessive flow of tears, closure of the eyelids, and incapacitation of exposed individuals. Apart from the effects on the eyes, these agents also cause irritation in the nose and mouth, throat, and upper airways. Occasionally, there is damage to the skin, particularly in moist and warm areas.

In situations where massive exposure has occurred, tear gas that has been swallowed may cause vomiting. Serious systemic toxicity is rare and occurs most frequently with CN; it is most likely to occur when these agents are used in very high concentrations within confined nonventilated spaces. Based on the available toxicological and medical evidence, CS and CR have a large safety margin for

Table 6.1 Examples of chemical restraint products available

Brand name	Ingredients	Delivery system
Cap-Stun	5% Oleoresin capsicum	Spray
Alan's Pepper Spray	10% Oleo capsicum pepper	Spray
Pepper Foam	10% Oleo capsicum	Foam spray
Pepper Gard, Triple Action Spray	10% Oleo capsicum and 10% CS	Spray
Mark III	5% Oleo capsicum and 5% CS	Spray

life-threatening or irreversible toxic effects. There is no evidence that a healthy individual will experience long-term health effects from open-air exposures to CS or CR, although contamination with CR is less easy to remove than other tear gases and irritant incapacitants such as 1-chloroacetophenone, 2-chlorobenzylidene malononitrile, and dibenz[*b*,*f*]-1,4-oxazepine [10].

Because these agents are relatively safe (obviously the various forms of fentanyl are not considered in this same category), these agents are excluded from international treaty provisions that address chemical weapons. The United States, England, Ireland, France, China, Korea, Israel, and Russia are just some of the countries that utilize these compounds as riot control agents. Legal availability to law enforcement and the general public differs between countries; however, most can be easily obtained through international markets or ordered through the Internet.

Chemical restraint compounds differ from most other chemical agents because they are solid particles with low vapor pressures. They are usually dispersed as fine particles or in a solution. For large crowds, aerial "bombs" have been developed that can be dropped to cause wide dispersal of the compound. These agents have also been formulated in grenades or canisters which can either be thrown by hand or shot as projectile devices. The most common method of dispersal is by individual spray cans that deliver a stream, spray, or foam containing the agent. These individual dispersal units were designed to render immediate incapacitation to an offender without the use of more forceful methods, thereby providing an extra means of control in the ladder of force used by law enforcement. Canisters containing a lower concentration of the active ingredient have been marketed to civilians for personal protection. There is no formal training for civilians on how these devices can be safely handled, and no laws govern their use, and no formal decontamination procedures have been recommended for use after exposure. This lack of training significantly increases the risk for exposure to the users, the as well as innocent bystanders.

Oleum Capsicum

Oleum capsicum (OC or PS) selectively stimulates nociceptors in exposed mucous membranes. Exposure to capsicum leads to the release of substance P, bradykinin, histamine, and prostaglandins. The physiologic effects of these mediators result in vasodilation, increased vascular permeability, pain, and altered neurotrophic chemotaxis. Other common symptoms are listed in Table 6.2.

Table 6.2 Common clinical findings with exposure to crowd control agents

Finding	CS	CN	OC
Ocular			
Lacrimation	✓	✓	✓
Blepharospasm	✓	✓	
Pain and/or burning	✓	✓	✓
Conjunctival injection	✓	✓	✓
Conjunctival edema	✓	✓	
Photophobia	✓	✓	
Corneal abrasion	✓	✓	✓
Impaired vision	✓	✓	✓
Upper airway			
Pain and/or burning	✓	✓	
Shortness of breath	✓	✓	✓
Increased secretion	✓	✓	
Congestion	✓		
Coughing	✓	✓	✓
Throat irritation	✓	✓	✓
Wheezing	✓	✓	✓
Irregular respiration[a]	✓	✓	
Dermal			
Pain	✓	✓	✓
Contact dermatitis		✓	✓
Blistering	✓	✓	✓
Miscellaneous			
Nausea/vomiting	✓		
Bad taste	✓		
Headache	✓		
Increased blood pressure	✓[a]		

[a]Initial response thought to be associated with pain

Capsicum in its pure form is a crystalline. The oleoresin extract of capsicum that contains over 100 volatile compounds that all act in a manner similar to capsicum itself [11]. Because the individual components of oleum capsicum may vary, so too will the relative pungency of the pepper type. Variation in quality control virtually guarantees that different formulations of the same extract will exhibit different degrees of effectiveness [11, 12].

One consequence of poor quality control is that enforcement officers may be at risk because the product they had been using did not contain enough active agent and was, therefore, ineffective [13]. Most OC preparations are formulated in a propylene vehicle to enhance adherence to the skin surface. PS is the most common spray marketed to civilians for a less-lethal, noncontact, self-defense. It can be purchased in a variety of sprays or foams, in various concentrations or combined with other crowd control agents such as CS (Fig. 6.1).

Fig. 6.1 Examples of individual spray containers containing crowd control agents

Watson et al. [7] evaluated patients presenting to an emergency department after PS exposure. Most patients complained of ocular irritation and pain at the site of exposure. The symptoms were transient, and very few required treatment. The most significant adverse effects were corneal abrasions that required treatment with topical anesthetics and topical antibiotics. Five of ninety-four patients complained of wheezing or shortness of breath, but no patient actually required treatment for bronchospasm, and two of the five had a history of reactive airway disease. No patient in this study had significant morbidity or mortality and all were discharged directly from the emergency department. There is no data to support the notion that PS exacerbates pulmonary disease or that patients with reactive airway disease are more sensitive to the effects of PS [7, 13, 14].

There have, however, been a few reports of severe reactions to PS. One case report described respiratory distress necessitating extracorporeal membrane oxygenation in a 4-week-old infant after a 5% PS was accidentally discharged in his face [15]. The infant had a difficult clinical course but recovered. Another case report summarized the clinical course of an 11-year-old child who intentionally sprayed himself and inhaled PS from an individual canister and developed reversible wheezing [16]. Since these cases are anecdotal, very little can be concluded from them. They certainly do not contact the observation that these adverse events have been rare.

Of concern are reports describing violent prisoners who died after being sprayed with pepper spray while being physically restrained. Such individuals are almost invariably found to be chronic stimulant abusers [17]. Here too, the anecdotal nature of these episodes must always be remembered, especially since decedents in such cases rarely have complete autopsies (histology omitted, no cardiac pathology or neuropathology studies, let alone neuro-chemical testing).

In the United States, it is not uncommon for legal actions to be lodged against police, charging that they used excessive force and that the prisoners died from "positional asphyxia" secondary to restraint, and that pepper spray played a contributory role in their deaths [18]. These actions are almost always dismissed for lack of evidence. There is, for example, there is no evidence that positional asphyxia even exists, or that it possibly could (except of course the classic case where someone is caught under a pile of people after the viewing stands have collapsed) [19]. In most cases where harm is alleged to have resulted from the application of chemical incapacitants, the decedents all have had other recognized risks factor for sudden cardiac death (such as ventricular remodeling) which is a cause of sudden death even in those not exposed to capsicum [20]. Nonetheless, violent prisoners, even if a chemical restraint has not been used, should be closely monitored and evaluated by appropriate healthcare professionals. A small population of acutely intoxicated individuals are at risk of sudden death, independent of their treatment.

The absence of any association between restraint, asphpyxia, and OC exposure was been demonstrated in a randomized, cross-over controlled trial where volunteers were sprayed with OC while restrained in a prone position [21]. Results from 35 subjects exposed to OC or placebo showed that inhalation of OC did not result in abnormal pulmonary function, hypoxemia, or hypoventilation when compared to those exposed to placebo, in either sitting position or in a maximal restraint position.

Treatment of exposure to PS is based on severity of symptoms. The first order of treatment should always be decontamination that includes actions to limit exposure, the most obvious being the removal of contaminated clothing. Copious irrigation of affected areas will attenuate the burning sensation [22, 23]. One must use caution not to contaminate other sites with the irrigating solution by washing PS from the hair into the eyes or oral pharyngeal mucosa. In one study, topical proparacaine was found to be helpful in alleviating ocular pain associated with OC exposure; approximately 50% of those treated had improved symptoms when compared to individuals treated with a topical nonsteroidal anti-inflammatory agent (0.03% topical flurbiprofen) or placebo [24]. It is important to note that there were no corneal abrasions in any of the 11 subjects in this study, and that 21% of the individuals had slit lamp evidence of punctuate epithelial erosions. In this study, as well as an additional

Fig. 6.2 Periocular swelling and facial contact dermatitis from pepper spray exposure during an arrest by law enforcement

exposure trial, the focal epithelial damage healed within 1 day, independent of treatment [25].

A slit lamp exam of the anterior chamber is warranted for those with persistent ocular complaints. Corneal abrasion must be ruled out. If present, the abrasion should be treated appropriately with topical local anesthetics, topical antibiotics, cycloplegics, analgesics, and follow up. Dermatitis associated with PS has been reported [26, 27]. Topical corticosteroids, systemic antihistamines, and analgesics have been employed in reducing symptoms. An example of rather severe PS dermatitis and ocular swelling is shown in Fig. 6.2. This particular patient was sprayed during arrest by police offices and brought to the hospital for evaluation. He was treated with irrigation, systemic antihistamines, and steroids with resolution of his symptoms within 4 days.

A cluster of adverse events associated with CS exposure that occurred during a U.S. Marine training exercise has been reported. Nine Marines were exposed to CS without the benefit of personal protective equipment. All participated in rigorous physical exercise within 3–4 days after exposure to CS and were subsequently hospitalized with various pulmonary symptoms including cough, shortness of breath, hemoptysis ($N=5$), and hypoxia ($N=4$). Four required hospitalization in an intensive care setting, five in a nonmonitored setting. All symptoms of respiratory distress abated within 72 h after onset, and all nine Marines had normal lung function 1 week after CS exposure [28].

Most of the dispersal methods for CS and CN achieve concentrations far below what is considered to be lethal [29]. However, there is some question as to the concentrations achieved in close proximity to grenades or other delivery devices. Based on animal studies, it is generally thought that a concentration of 25,000–150,000 mg/m^3/min or 200 mg/kg body mass represents the LD50 for CS. A grenade can generate a concentration of 2,000–5,000 mg/m^3 at the center, with concentrations becoming significantly less within a few yards from the center of the explosion [29]. Regardless of the presumed degree of exposure, if an individual not wearing personal protective equipment does develop respiratory symptoms, then extensive evaluation is required.

Treatment of CS exposure is based largely on the severity of clinical findings. The majority of patients will fully recover within minutes after removal from the agent and will not require medical attention [30]. The most common lasting complaints are facial and ocular irritation. In contrast to other forms of chemical exposure, irrigating the affected area will only intensify and prolong the effects of CS gas or particles. For patients who require medical evaluation, the first order of treatment should always be removal of contaminated clothing with special attention to eliminating secondary exposure by using protective equipment and not placing a contaminated patient in a confined space. Clothing should be removed outside and placed inside a plastic bag, then bagged again. Blowing dry air directly onto the eye assists in vaporizing the dissolved CS gas [31]. Some clinicians have recommended copious ocular irrigation with sterile saline, although this has been thought in some cases to cause an initial acute increase in ocular irritation[32]. A careful slit lamp exam of the anterior segment of the eye, including evaluation under the lids, should be done for persistent ocular irritation. If particles have become imbedded in the cornea or under the lids, they should be removed. If corneal abrasions are present, a few days of topical broad-spectrum antibiotics, cycloplegics, and appropriate analgesics are in order.

Dermal irritation in the form of burning and blistering can be treated with irrigation, preferably with an alkaline solution other than sodium hypochlorite [26]. Erythema can be common in skin that has been freshly abraded, but resolves 45–60 min after exposure. Contact dermatitis can be effectively treated with topical corticosteroids and/or antihistamines such as diphenhydramine. Typically, dermatitis associated with CS exposure resolves within a few days [26].

Home remedies such as application of cooking oils are contraindicated and pose an increase risk for irritation and infection [32]. Sodium hypochlorite solutions will exacerbate any dermal irritation and should not be used. Plain soap and water is effective, but in most cases, removal of clothing in a well-ventilated area is all that is needed.

There are conflicting reports about the long-term effects of CS exposure. With an exposure to high concentrations, especially if prolonged and occur in a confined space, pulmonary edema, pneumonitis, heart failure, hepatocellular damage, and death may result [8, 33]. There is no data to support claims of tetratogenity, or even toxicity to the pregnant woman [8, 34]. Nor do these agents appear to exacerbate chronic diseases such as seizure disorders, respiratory disease, or psychiatric illnesses. Contact allergies in those previously exposed have also been reported [35–37].

The possibility of secondary exposure to healthcare and law enforcement providers exists with the use of chemical crowd control agents. Although published reports are few, effects can be minimized with common sense practices such as decontamination before the patient is placed in a confined area such as a police car, ambulance, or a confined room in the emergency department. The use of

Table 6.3 Options for treatment for exposure to chemical crowd control agents

Treatment	PS	CS	CN
Removal of contaminated clothing	✓	✓	✓
Ocular irrigation	✓		✓
Dermal irrigation	✓	✓	✓
Alkaline solution irrigation of skin		✓	✓
Soap and water decontamination	✓	✓	✓
Topical steroids for dermatitis	✓	✓	✓
Systemic antihistamines for dermatitis	✓	✓	✓
Systemic steroids for dermatitis	✓	✓	✓
Topical antibiotics for corneal abrasion	✓	✓	✓
Cycloplegics	✓	✓	✓
Analgesics for pain	✓	✓	✓

protective personal equipment such as gloves and careful washing of exposed areas avoids cross-contamination. The Faculty of Forensic and Legal Medicine (FFLM) publishes recommendations for forensic physicians, custody nurses, and paramedics on the clinical effects and management of incapacitant sprays [38].

Conclusions

Chemical crowd control agents must be used judiciously, correctly, and as an alternative to more dangerous use of force. Law enforcement officers should be educated about the common clinical effects of these chemicals and the need for medical evaluation. Medical care should never be withheld from those who request it, or prisoners complaining of lingering effects. Treatment of exposure is summarized in Table 6.3. Because of their profoundly benign status, use of chemical crowd control agents is relegated to the lowest level of force that can be applied; however, it is also worth emphasizing that those most likely to be sprayed with one of these agents are those who are least likely to be responsive – the acutely psychotic. Thus, it must be recognized that, even though these agents are relatively benign, their use is not always appropriate.

References

1. Strote J et al (2010) Use of force by law enforcement: an evaluation of safety and injury. J Trauma 68(5):1239–1246
2. Gray PJ (1997) CS gas is not a chemical means of restraining a person. BMJ 314(7090):1353
3. Hu H et al (1989) Tear gas – harassing agent or toxic chemical weapon? JAMA 262(5):660–663
4. Derbeken V (1997) Pepper spray in the eyes – protestors file suit against police, in San Francisco Chronicle. Herst Publications, San Francisco

5. MacDonald JM, Kaminski RJ, Smith MR (2009) The effect of less-lethal weapons on injuries in police use-of-force events. Am J Public Health 99(12):2268–2274
6. Brone B et al (2008) Tear gasses CN, CR, and CS are potent activators of the human TRPA1 receptor. Toxicol Appl Pharmacol 231(2):150–156
7. Watson WA, Stremel KR, Westdorp EJ (1996) Oleoresin capsicum (Cap-Stun) toxicity from aerosol exposure. Ann Pharmacother 30(7–8):733–735
8. Tominack RL, Spyker DA (1987) Capsicum and capsaicin – a review: case report of the use of hot peppers in child abuse. J Toxicol Clin Toxicol 25(7):591–601
9. Lee RJ et al (1996) Personal defense sprays: effects and management of exposure. J Am Optom Assoc 67(9):548–560
10. Blain PG (2003) Tear gases and irritant incapacitants. 1-chloroacetophenone, 2-chlorobenzylidene malononitrile and dibenz[b, f]-1,4-oxazepine. Toxicol Rev 22(2):103–110
11. Cordell GA, Araujo OE (1993) Capsaicin: identification, nomenclature, and pharmacotherapy. Ann Pharmacother 27(3):330–336
12. Haas JS et al (1997) Chemical and elemental comparison of two formulations of oleoresin capsicum. Sci Justice 37(1):15–24
13. Reilly CA, Crouch DJ, Yost GS (2001) Quantitative analysis of capsaicinoids in fresh peppers, oleoresin capsicum and pepper spray products. J Forensic Sci 46(3):502–509
14. Collier JG, Fuller RW (1984) Capsaicin inhalation in man and the effects of sodium cromoglycate. Br J Pharmacol 81(1):113–117
15. Billmire DF et al (1996) Pepper-spray-induced respiratory failure treated with extracorporeal membrane oxygenation. Pediatrics 98(5):961–963
16. Winograd HL (1977) Acute croup in an older child. An unusual toxic origin. Clin Pediatr (Phila) 16(10):884–887
17. Mash D et al (2009) Brain biomarkers for identifying excited delirium as a cause of sudden death. Forensic Sci Int 190(1–3):e13–19
18. Karch SB, Stephens BG (1999) Drug abusers who die during arrest or in custody. J R Soc Med 92(3):110–113
19. Glatter K, Karch SB (2004) Positional asphyxia: inadequate oxygen, or inadequate theory? Forensic Sci Int 141(2–3):201–202
20. Maeda H et al (2009) Potential risk factors for sudden cardiac death: an analysis of medicolegal autopsy cases. Leg Med (Tokyo) 11(Suppl 1):S263–S265
21. Chan TC et al (2002) The effect of oleoresin capsicum "pepper" spray inhalation on respiratory function. J Forensic Sci 47(2):299–304
22. Burnett JW (1989) Capsicum pepper dermatitis. Cutis 43(6):534
23. Jones LA, Tandberg D, Troutman WG (1987) Household treatment for "chile burns" of the hands. J Toxicol Clin Toxicol 25(6):483–491
24. Zollman TM, Bragg RM, Harrison DA (2000) Clinical effects of oleoresin capsicum (pepper spray) on the human cornea and conjunctiva. Ophthalmology 107(12):2186–2189
25. Vesaluoma M et al (2000) Effects of oleoresin capsicum pepper spray on human corneal morphology and sensitivity. Invest Ophthalmol Vis Sci 41(8):2138–2147
26. Holland P, White RG (1972) The cutaneous reactions produced by o-chlorobenzyl-idenemalononitrile and -chloroacetophenone when applied directly to the skin of human subjects. Br J Dermatol 86(2):150–154
27. Penneys NS, Israel RM, Indgin SM (1969) Contact dermatitis due to 1-chloroacetophenone and chemical mace. N Engl J Med 281(8):413–415
28. Thomas RJ et al (2002) Acute pulmonary effects from o-chlorobenzylidenemalonitrile "tear gas": a unique exposure outcome unmasked by strenuous exercise after a military training event. Mil Med 167(2):136–139
29. Weigand DA (1969) Cutaneous reactions to the riot control agent CS. Mil Med 134:437–440
30. Punte CL, Owens EJ, Gutentag PJ (1963) Exposures to orthochlorobenzylidene malononitrile. Controlled human exposures. Arch Environ Health 6:366–374
31. Yih JP (1995) CS gas injury to the eye. BMJ 311(7000):276
32. Folb PI, Talmud J (1989) Tear gas – its toxicology and suggestions for management of its acute effects in man. S Afr Med J 76(7):295

33. Krapf R, Thalmann H (1981) [Acute exposure to CS tear gas and clinical studies]. Schweiz Med Wochenschr 111(52):2056–2060
34. Upshall DG (1973) Effects of o-chlorobenzylidene malononitrile (CS) and the stress of aerosol inhalation upon rat and rabbit embryonic development. Toxicol Appl Pharmacol 24(1):45–59
35. Maucher OM, Stengel R, Schopf E (1986) [Chloroacetophenone allergy]. Hautarzt 37(7):397–401
36. Fuchs T, Ippen H (1986) [Contact allergy to CN and CS tear gas]. Derm Beruf Umwelt 34(1):12–14
37. Fuchs T, in der Wiesche M (1990) [Contact allergies to CN and CS ("tear gas") in participants in demonstrations]. Z Hautkr 65(3):288–292, 295
38. FFLM; McGorrigan J, Payne-James JJ (2010) Recommendations. Incapacitant sprays: clinical effects and management. http://www.fflm.ac.uk. Last Accessed 22 June 2011

Chapter 7
Medical Issues Relevant to Restraint

Philip S.L. Beh

Introduction

In this modern era and in places where there is a functioning government with a robust judicial institution, the clash between individual rights and demands and those of the state or institutions will occur and will be subject to often intense public scrutiny. Readers will have watched television news broadcasts of large-scale protests and demonstrations at meetings of World Trade Organisations, Climate Change Summits, etc.

This chapter makes no attempt at answering what the norms or limits should be in the interaction between police and such demonstrators but will look at the various medical issues that such interactions between the police and the public may give rise to, and in particular, what the healthcare professional called in to examine and record evidence of such encounters should be aware of so as to enable them to perform a thorough and detailed examination and draw conclusions that can be supported by medical evidence.

The healthcare professional's involvement with these issues involves many of the core attributes needed in the practice of high-quality forensic medicine. These include the need for good history, taking from as many involved parties as is practical to clearly establish events, and a precise examination recorded clearly and contemporaneously. Objectivity must be maintained in the light of differing histories, and there is a need to keep abreast of developing restraint techniques which may bring new clinical problems. However careful police officers may be, there is the potential for serious injury requiring further medical intervention, and the real possibility of being a witness in a legal process such as police disciplinary procedures.

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During restraint, any force used must be proportionate to the threat faced, be lawful and necessary. The restraint process is particularly challenging where the potential detainee has a mental health problem or is intoxicated. In addition, the officer must be able in retrospect, and under close scrutiny, to demonstrate that his actions were entirely appropriate. It must be recognized that at the time of restraint, officers may not have the luxury of time for a full analysis using prior information, or the knowledge that experience, combined with extensive training and re-training, brings. As an independent doctor, excellent clinical management by the forensic physician throughout the case enables the doctor to act as a high-quality witness if needed. The doctor also has a duty to report any instance where excessive restraint appears to have been used and such concerns should be communicated to the senior police officer on duty immediately. The forensic physician needs to be aware that equipment may be misused so that a long barreled metal torch could be used as a striking weapon in some circumstances and indeed such lights were withdrawn in the United States to prevent this happening.

The Use-of-Force Continuum [1]

Police forces around the world will have policies and guidelines for their officers on when and how much force they can legitimately use in the line of duty. Individual police forces are likely to have their own version of such guidelines but it is likely that they will include some or most of the following:

Officer presence – The simple presence of uniformed officers at an incident may be an effective means of establishing order. Such presence may vary from a single officer at petty disputes to large numbers of teams of police officers in riot gear, in armoured vehicles, and in some jurisdictions even mounted police officers; when such presence results in amicable outcomes, all involved are contented.

Verbalization – Here officers may need to shout or broadcast warnings to an individual or to crowds. Again, where consensus can be reached, it will gain a satisfactory outcome.

Empty hand control – From this point on there is physical contact between the officer and a member of the public. The outcome of such an encounter often depends on the degree of force used by the officer as well as on the degree of resistance put up by the person that the police officer has identified for "control". For example, in a situation where protesters lie on the street and allow the police to lift and remove them without any resistance, no or minimal injuries are expected. On the other hand, if an officer had chased and tackled a person running, one may expect to find injuries on both the officer and the subject. In some jurisdictions, officers are allowed to punch or kick to restrain an individual. In such instances the presence of injuries from such punches or kicks are of course to be expected.

Non-lethal force – Here officers will be using force in responding to an individual. Such non-lethal force will often involve the use of:

Batons – Batons come in different forms from the almost iconic wooden baton to longer extendable metallic tubes, etc. Essentially, police officers would have received training on the use of such “weapons” and in particular on where and how to strike individuals to disarm them and or to inflict sufficient pain to allow for the police officers to restrain such individuals.

Up to the early 1990s, UK police officers were equipped with a short wooden truncheon about 40 cm long and weighing just under 300 g. There was little formal training with these but actual usage was not that common, either because they were not terribly effective or the situations faced at that time could be dealt with in different ways. In 1993, trials of both sides handled and a number of straight batons were introduced, as there was a rise in the number of officers injured on duty and the adequacy of their equipment was called into question.

Within the UK batons are of three types:

1. The Monadnock PR24 side handled baton can be either a rigid one piece baton or extendable from a shorter form for easier transport. Weighing around 600 g with a shaft of polycarbonate plastic or aluminium, it has a fixed grip at right angles to the shaft towards one end. It is about 60 cm long. The addition of the handle to the shaft makes it very versatile with over 30 blocking and striking techniques available to the officer. Correct usage in stressful and challenging situations requires extensive and ongoing training. In some restraint situations, baton strike from the PR24 type is ineffective at producing the desired effect as not enough energy can be imparted from the strike.
2. The straight friction lock baton (e.g. the Asp) weighs less at 560 g and extends from 13 to 39 cm when racked (extended) with a flick of the wrist. It is carried unobtrusively on the belt and does not impede the general movement of the officer. It is made of hollow gun metal with a small metal knob at the far end. This gives more weight distally, but it is prone to becoming flattened and rough over time as the baton is closed by striking this end against the ground. This change in shape may increase the chance of injury in a forceful strike.
3. The acrylic patrol baton type has a solid or hollow nylon shaft with a ring of rubber separating the shaft and handle. It has fixed lengths of 56, 61 and 66 cm. It is broader than the friction lock type and therefore less likely to cause injury because the imparted energy is spread over a larger area. This is even though its weight is slightly less at 500–580 g. The heavier weights of these types of batons are used in public order disturbances.

In the United States, a 26 in. hickory (wooden) straight baton is used (similar to group 3 above). The situation across the Australian states is very variable with intra-state differences relating to specific police staff; for example, plain clothes staff may use an Asp type whereas uniformed officers are equipped with straight or side-handled batons.

Batons are used in offensive and defensive strikes, blocks or jabs. Strikes are made from an officer’s strong (dominant) or weak (non-dominant) side, and clearly the potential for injury varies with the baton mass and velocity at impact, the target area and over how much surface area the force is applied to. Although no body area is absolutely forbidden to strike, an officer must use a proportionate response to the situation he faces knowing the potential to injure. Although target areas are divided into low-, medium- and high-risk areas as below, maintaining a distinction between them could be very difficult as strikes are made in dynamic situations where an initial target area may change as the potential detainee moves.

Target areas with a low injury potential are the areas of the common personnel, femoral and tibial nerves on the legs and those of the radial and median nerves on the arms. There is a low probability of permanent injury with the main effects being seen as short-lived motor nerve dysfunction, as in a “dead leg”, and bruising.

The medium injury potential areas involve bones and joints including the knees and ankles, wrist, elbow, hands, upper arms and clavicle. In these cases fractures, dislocations and more extensive soft tissue injuries would be expected. Lastly, those areas with the highest risk of injury include the head, neck, throat, spine, kidneys and solar plexus.

The commonest injury to be seen will be bruising, and this is often in the pattern of so-called “tramline bruising” where two parallel lines of bruising are separated by a paler area. This is not unique to a baton injury but reflects an injury caused by any cylindrical hard object. The absence of bruising or other findings does not mean that a baton was not used as, for example, a degree of cushioning can occur from clothing. If the end of a baton is used to jab with, then circular bruises may be seen. It is possible for a detainee to have signs but with minimal symptoms or even be unaware of being struck. However, a move towards the friction lock batons makes this less likely.

An impact over a bony surface may produce a laceration. Abrasions are possible from the surface of a damaged baton. Fractures need to be considered where there are the traditional clinical signs of local pain, swelling and loss of function. X-ray confirmation is needed as soon as possible.

Considering the forces which can be applied when necessary, there is the potential for significant injury with bruising and rupture of internal organs including the heart, liver, spleen or kidneys or a head injury. The forensic physician should refer suspected cases for hospital review without delay especially if a confirmatory history for events is unavailable. Particular care is needed in those who are intoxicated as they are difficult to assess.

Individually held chemical sprays or gas canisters that are delivered from handheld devices or armoured vehicles are increasingly popular and work to disorientate and to transiently incapacitate an individual. Details of the use and effects of these are covered elsewhere in Chap. 6 of this book.

Energy devices in the form of stun guns and tasers are used by quite a large number of police forces in North America, UK, Australia and in China. Details of the effects of these are covered in Chap. 8.

New devices are constantly been tested and promoted and include restraining nets, propelled bean bags, bright lights, laser dazzlers, noise, etc. New forms of crowd control barriers such as large water filled blocks that are heavier and sturdier have also been used.

Water canons are often mounted on armoured vehicles and are capable of directing a powerful jet of water over long distances and with such force that grown adults are knocked off their feet.

Rubber bullets are hard solid chunks of rubber that are shot from a shot-gun like device. These bullets when used properly can cause painful soft-tissue injuries but have been known to cause fatal injuries when used improperly or when vulnerable parts of the body had been struck.

Lethal force – Here officers aim to prevent a lethal threat to another person or to avoid a lethal threat to himself.

Doctors involve in the examination and evaluation of individuals following an arrest must be aware of the above concept of the “use of force continuum” as such understanding will allow a much more informed ability to form opinions and comments on the sequelea of the use of such force. Ultimately though, it would be for the appropriate courts and tribunals to decide on the appropriateness of an officer’s decision on how much force was used in response to a threat posed or perceived.

Methods of Physical Restraint

Physical restraint of an individual involves actual physical contact. The outcome of such contact is of course a function of the degree of force applied to restrain an individual and the degree of force used to resist such a restraint.

Upper Limb Restraints

A simple tight hand grip of a wrist, forearm or arm of an individual could easily result in bruises over the areas of the hand grip, such bruises may range from fingertip bruises to larger patches of bruises. Forceful struggle against such a restraint will of course lead to bigger or more areas of bruising from repeated attempts to grip, etc.

In situations where the individual’s arm may be forced to the back of the body to facilitate the application of hand-cuffs, dislocation of the shoulders can occur.

Body Tackles

Body tackles will often result in falls of both the officer attempting to restrain the individual as well as the individuals. Injuries will typically include bruises and abrasions over hands, elbows, knees, etc. However, in situations where the fall was on a hard surface or was more complicated, more complex and severe injuries such as fractures may be seen. In many instances with such body tackles, the individual would end up lying on the ground and the arresting officer applying various degrees of force to keep the individual on the ground.

Occasionally, deaths have occurred when it was suggested that several officers had jumped on an individual in such a position and such an individual was traumatically asphyxiated by the weight of all these officers acting on him.

Neck Holds

These are perhaps the most controversial form of physical restraint and the most problematic. Proponents of such holds claim that they are safe and effective and attribute the origin from judo, which has been around for centuries. Such holds are used in competition regularly with very rare if ever reports of serious injury or fatality. Others argue that such a means of restraint is inherently unsafe and has too narrow a margin for error to be used for restraint of an individual.

Neck holds have been divided by many authors into:

(a) Forearm holds – Such a hold involves the use of the forearm placed horizontally across the front of an individual's neck. The person applying the hold is positioned at the back and using the free hand, this forearm is pulled backwards forcing the individual's neck structures particularly the trachea against the cervical spine, hence constricting it and causing difficulty in breathing. Theoretically, the individual restrained ceases to struggle and resist restraint because of this difficulty in breathing.
(b) Sleeper holds – This hold is even more ambitious as it purports to apply pressure on the carotid sinuses, and hence result in transient loss of consciousness. It is applied by placing the entire upper limb around an individual's neck so that the neck is caught or pinched between the arm and forearm. Flexion of the elbow joint applies pressure to both sides of the neck and the individual loses consciousness, and hence is restrained.

Such a division is helpful in appreciating the supposed intended effects of these holds. In practical situations where an individual may be violently struggling, such a clinically accurate application of neck holds will be challenging to perhaps most, apart from the highly skilled and practiced judo exponents. No matter how well and how many individuals in a police force are trained on the use of these holds, it will be unusual that they will be able to maintain such expertise in the course of their career and also to have sufficient and regular opportunities to use such holds so as to be truly experts in their safe use.

The Pathophysiology of Neck Holds

Most forensic literature, even those published in the last decade attributes the effects of neck holds to one or more of the following:

1. The "forearm hold" applies pressure across the front of the neck and hence also on the thyroid cartilages. Indeed, where excessive force has been applied, fracture of the thyroid cartilages may be found.

2. The “forearm hold” will also result in the backward displacement of the tongue, hence occlusion of the hypopharynx.
3. The “sleeper” hold on the other end is believed to result in compression of both carotid arteries, hence decrease the carotid blood flow to the brain. Reay and Holloway [2] are often quoted as having demonstrated that the application of such a neck hold decreases blood flow to the head by 85%.
4. The “sleeper” hold may also be due to stimulation of the carotid sinus, which can produce bradycardia and a transient loss of consciousness. Carotid sinus stimulation is a common enough finding and hence conceptually this alleged mechanism commonly referred to as the “vasovagal effect” was often offered when no definitive findings were present to indicate another mechanism for the cause of death.

More recent reviews by Ross and Chan [3] as well as Di Maio and Di Maio [4] have collected experimental as well as focused serial collections whereby many of the above supposed or accepted mechanisms were challenged. Indeed, readers are encouraged to reflect on the rather provocatively titled article from Glatter and Karch [5]. Indeed, they call for a clearer focus on such cases and have supported the use of the collective term of Excited Delirium Syndrome to study such deaths.

There is no doubt that excessive force applied to the neck in any neck holds that results in injury to the laryngeal cartilages especially the thyroid cartilages can lead to serious neck injuries and possibly death. It is suggested that to kill, the hold would need to be applied for at least 2 or more minutes. In reality, this is quite a long time and seldom supported by independent witnesses to deaths in such incidents.

Vilke [3] in reviewing the work of Reay and Holloway argues that the decreased blood flow was “capillary” in nature and may represent a decrease in blood inflow as well as blood outflow from the brain. The decreased blood outflow from the brain, effectively a result of the increased pressure from the neck hold, increases the venous pressure in the neck.

Raschka et al. [6] performed measurements on nine judokas and were able to demonstrate a reduction in the end-diastolic flow in the mid cerebral artery from a baseline peak flow of 85.3–4.2 cm/s. What was however more relevant was that none of the subjects lost consciousness and even more pertinent was that a pulse oximetry reading from a probe on the ear measured only a decrease from 97.9 to 93.2% only during the hold.

The carotid sinus syndrome can be diagnosed when carotid sinus stimulation produces a systole exceeding 3 s or a fall in systolic pressure exceeding 50 mmHg. However, this syndrome is found usually in older individuals. In two different studies, each involving 25 elderly subjects, Parry et al. [7] and McIntosh et al. [8] were unable to produce the above physiological changes in the majority of the subjects. Indeed McIntosh was able to produce a drop in blood pressure of more than 50 mmHg in only three individuals. Suffice to say that none of the subjects demonstrated any near-death changes.

It is now believed that sudden death in the course of an arrest where neck holds and or restraints are used particularly involving a violent struggling individual are multifactorial with inter-linked causations. This has become fashionably referred to as death due to excited delirium syndromes [4].

Physical Restraining Devices

Handcuffs

By and large the most commonly used restraining device is that of the metal handcuffs and to a lesser extent waist and ankle chains.

Most handcuffs are fitted to both wrists of an individual with their hands behind their back. In some jurisdictions, individuals are handcuffed with their hands in front, which is a much less desirable position for restraint. Recently, released guidance on the use of handcuffs by The Association of Chief Police Officer of England, Wales and Northern Ireland [9] makes it clear that the use of handcuffs is an "intentional application of force to the person" and amounts to an assault unless it can be justified. Such justifications can be summarized simplistically as:

1. A person may escape or attempt to escape.
2. A person is likely to use violence.
3. Assuming custody of prisoners from Her Majesty's Prisons.

Up to the early 1990s handcuffs linked both wrists by a short metal chain but apart from restricting arm movements they offered little else in terms of restraint and if only one wrist was attached to them the handcuffs could quickly become a flail like weapon. Rigid handcuffs, such as Kwik Cuffs, were first trialled in 1993 and have since become standard issue in the UK and the USA. Within Australia, there is a mixed usage of chain and fixed link handcuffs.

Although the ratchet mechanism is the same as with the older cuffs, the fixed joint between the cuffs gives several distinct advantages. Holding the fixed joint allows easy application as simple pressure against the wrist enables the single bar to release over the wrist and engage the ratchet. The ratchet can be locked to prevent further tightening but can also only be released with the key, which requires the detainee to cooperate by keeping still. If the cuffs are not locked then progressive tightening can occur. Correctly tightened cuffs should just have enough space for an additional finger between the applied cuff and wrist. The hands are usually cuffed behind the back one above the other, as handcuffing to the front may still give opportunities to resist detention.

Even with only one wrist within the cuffs, control by the officer can be gained by essentially using the free cuff and rigid link as a lever to apply local painful pressure to the restrained wrist. Techniques allow a detainee to be brought to the ground in a controlled manner or the other wrist to be put within the cuffs. A very gentle application, such as may be experienced by the forensic physician in a personal trial, will demonstrate that it is clearly an effective way of gaining control of most individuals. This may not be the case in those who are intoxicated, have mental health issues or are violent. Cuffs should fit firmly but not tightly at the narrowest part of the wrist just distal to the radial and ulna styloid processes.

Injuries from Handcuffs

Injuries from handcuffs either reflect relative movement between the cuff and wrist or are the result of direct pressure from the cuff to the tissues of the wrist. It is important to remember that injuries may be unilateral especially where there has been resistance to their application.

The commonest injuries to be found are erythema, abrasions and bruising particularly to the radial and ulna borders of the wrist [10]. The erythema is often linear and orientated circumferentially around the wrist following the line of the handcuffs reflecting direct pressure from the edge of the cuffs. Bruising is commonly seen on the radial and ulna borders with tender swelling often associated with abrasions or superficial linear lacerations from the edge of the cuff. Abrasions reflect relative movement between the cuff and skin surface. However, it is not possible to determine whether this movement is from the cuff moving over the wrist or the wrist moving within the cuff, as the effect of either can produce the same skin abrasions. All of these soft tissue injuries will resolve uneventfully over the course of several days and only symptomatic treatment with simple analgesia and possibly a cold compress is required. Although rare, it is possible to have wrist fractures from restraint using hand cuffs. The styloid processes are the most vulnerable but scaphoid fractures have been reported [11]. Tenderness beyond that expected for minor injuries and especially tenderness in the anatomical snuff-box will need an X-ray assessment as soon as possible.

The earliest reports of sensory damage to the nerves of the wrist first appear in the 1920s with sensory disturbance often restricted to a small patch of hyperaesthesia and hyperalgesia on the extensor aspect of the hand between the thumb and index finger metacarpals [12]. This area reflects damage to the superficial branch of the radial nerve and subsequent studies confirm that this nerve is most commonly affected by compression between handcuffs and the dorsal radius [13]. However, injuries to the median and ulna nerves can also occur and these may be in isolation or in any combination. The superficial branch of the radial nerve may be spared with others being damaged [14]. Resultant symptoms are reported as lasting up to 3 years in one case; pain may be severe and prolonged, although the most disturbing symptom to patients is paraesthesiae [13]. Nerve conduction studies may be used to distinguish between a compressive mononeuropathy and a radiculopathy. The majority of cases with significant nerve damage either involve detainees who are intoxicated or have a clear history of excessive pressure being applied by the officers [13]. Intoxication may cause problems through a decreased awareness of local pain, marked uncooperativeness or poor memory for the restraining episode when a significant struggle had occurred. It is possible to have nerve damage with no skin breakage reflecting undue pressure. Although some of the quoted studies predate the introduction of rigid handcuffs, because of the similar ratchet mechanism direct pressure problems are still possible.

Sensory nerve damage causes loss of pain, touch and temperature sensation over an area of skin which is smaller than the nerve's sensory supply because of the considerable overlap between the sensory territories of adjacent peripheral nerves. Lesser degrees of damage lead to tingling, pain and numbness in the appropriate sensory distribution. In acute compression of the nerve, symptoms appear more or less abruptly, and relief of this acute compression should lead to resolution in the course of some weeks. Associated motor weakness can be demonstrated by the correct clinical test within the hand. It should be noted that compression of the radial nerve at the wrist does not result in weakness.

Leg Irons and Chains

Leg iron cuffs and chains are not as frequently used but are seen in the transport of arrested persons particularly those felt to be at a high risk of attempted escape. In less developed jurisdictions, such devices are often routinely used even in the custodial cell.

The proper use of handcuffs even over a long period of time should not result in any serious injuries to a restrained individual. Still, prudence demands that any person so detained should be regularly monitored to ensure that there is no undue distress from the restraining devices.

Plastic Fasteners

These self-locking devices are made up of tough plastic and are frequently used in situations where it is anticipated that there will be many persons who will have to be restrained, such as during riots or even in combat situations. Again, when used appropriately and only for periods of time requiring them, such devices are generally safe. In situations where individuals may have also been subjected to chemical restraint compounds such as tear gases, pepper sprays, etc. custodial officers should exercise a higher degree of vigilance for individuals who may be in distress and arrange for transfer of such individuals to better physical locations where better restraint devices can be deployed if indeed.

Plastic fastener are cheap to manufacture and are effective. In contrast to handcuffs however, these fasteners will get tighter if individuals foolishly attempted to pull at the loose ends. Too tight an application may compromise blood supply or injure nerves caught against a bone. Hence, such restrainers should be used for as short a time as possible and with the awareness that it may cause serious injuries to the constricted limbs. In less civilized societies, these fasteners have been used to secure fingers or thumbs instead of wrists and can lead to serious injury and possible need for subsequent amputation of such thumbs and fingers.

Restraint Positions

As described in earlier passages, it is common in the course of an action to physically restrain an individual, particularly those who struggle and resist arrests, to end up on the ground face down, either having been body tackled, or having a neck hold applied to subdue them so as to facilitate the application of handcuffs to the back of the body. In fact, it is common to see in the movies or on TV police dramas that an individual is ordered to surrender, place their hands over their head and lie flat face down on the ground. In the majority of arrests, this is safe for all concerned if the individual complies with police instructions.

Care should however be taken for individuals who may have a decreased level of consciousness either from the use of alcohol and/or drugs. Even more problematic are individuals who may be excitable because of intrinsic or drug-induced delirium. Awareness should also be developed in officers who may be dealing with individuals from other cultures who may be bewildered because they do not understand the language or the procedures of the land. Cases of deaths occurring during arrest will result in intense media and public scrutiny in most civilized societies.

One particularly notorious restraint position is the so called “hog-tie” position. In this position, not only are the individual’s hands tied behind the back, they are further tied to the ankles; such that the individual’s knees are flexed and the torso may be hyper-extended.

Another form of restraint is the so called “hobble prone restraint position”, now also referred to as total appendage restraint position (TARP). Here the ankles are restrained but may or may not be tied to the wrists. When they are tied to the wrists, much more slack is available such that there is less or little flexion of the knees required.

Deaths have been reported around the world involving persons arrested and placed in such positions, although the actual causes of deaths concluded are varied [3, 15]. Forensic pathologists traditionally agree and believe that the respiratory system is compromised as a result of the position of the body, the splinting of the arms restricting the efficiency of respiratory muscles, combined with elements of central nervous depression from alcohol, drugs or occasionally head injuries.

Review of the Patho-Physiological Effects of Restraint Positions

Critical review of the role of the body weight, body position, etc. associated with the hogtie and TARP positions by Neumann [16] challenges the simplistic argument accepted by many forensic pathologists. Neumann describes the results of several experimental studies by Chan et al. [17], Schmidt and Snowden [18] and Parkes [19], where a variety of physiological measurements such as FVC, FEV1, PaO_2, $PaCO_2$, etc. were taken and measured. No scientific basis was found to even support any significant deterioration in the respiratory abilities of the test subjects.

Chan et al. [20] further conducted a study whereby the "hobble" position and inhalation of pepper spray was combined with no significant respiratory deterioration observed. A third study was conducted by Chan et al. [21] whereby 25 and 50 pound weights were placed over the back in between the shoulder blades of individuals who were placed at the maximal prone restraint position. Readings were compared with when these same individuals were sitting. They recorded decreases in the FEV of 5% with the 25 pound weight and 9% with the 50 pound weight and concluded that such changes were clinically irrelevant.

A retrospective study by Stratton et al. [22] should be reflected upon. This study although retrospective gathered data on 216 cases of "excited delirium syndromes" witnessed by emergency medical services personnel. All these individuals had been "hog-tied" with their wrists and ankles bound together behind their back. There were 20 deaths. Two were excluded from the study as one had died from a pulmonary emboli and another had ligature marks and contusions of the neck. 18 deaths were attributed to be a result of "excited delirium syndrome". Despite the presence of emergency medical services personnel there were no successful resuscitation of the cardiac arrests that were observed. It was further observed that all cardiopulmonary arrests were preceded by a short period of about 5 min of laboured or shallow breathing after the struggle had ceased. At autopsies, 9 of the 18 individuals had markedly enlarged hearts. Cocaine and/or methamphetamine were present in 78% of the cases. It was also observed that 50% of the individuals who died were obese; however, given the population norm of possibly 65% obesity, this finding could not be commented further.

Restraints in Medical Facilities

Restraints are commonly used in medical facilities and occasionally deaths of such patients occur. Investigation of such deaths should be equally thorough and vigorous. Most medical institutions would have written protocols detailing why, when and how different types of restraint devices can be used.

It is important to remember that such decisions should not be taken likely and should involve as best as possible the patient and/or the patient's immediate family working towards a situation that best meets the interests of the patient. When restraint devices are used, medical and nursing staff should ensure that proper monitoring of vital parameters and the patient's condition is instituted and regularly reviewed.

Restraint devices such as restraint jackets must be properly made to internationally recognized standards. The size of such jackets must be appropriate as too small a jacket may result not only in discomfort but also in possible physical restriction on breathing and eating. Too large a jacket will allow unwanted wriggling and attempts to "escape". Deaths have occurred with the use of such restrainer jackets in elderly patients. The author has seen deaths where an elderly lady may have slipped or attempted to get out of bed and was "hanged" by her restraining jacket that had not been properly sized and secured. In another case, an elderly male was strangled when he became caught up in a "home-made" restrainer vest that had very long straps that were tied to a suspension point at the top of the bed in an effort to prevent the elderly gentleman from wondering around at night.

Physical Examination

It goes without saying that once a person is restrained and the situation is brought under control, the continual use of the restraint must be evaluated regularly as to its appropriateness. It is not unexpected that individuals who have been restrained may lodge of a complaint or mount a legal challenge to their restraint and detention.

When a doctor is asked to examine such an individual, an informed consent for the examination, photography and release of the report should be obtained.

Allegations of assaults should be recorded verbatim if possible and a full and thorough physical examination performed. All injuries should be properly described, located and measured. Colour photography with scales should be taken and kept with the records.

Bruises and abrasions will be commonly found. Abrasions over bony prominences may have resulted from falls and tumbles. Abrasions or bruised abrasions over the bony prominences of the wrists may be a result of handcuffs. Occasionally, tram line bruises are found and these may be due to blows from batons. Fingertip bruises may also be found over areas of the upper limbs where an individual may have been held.

Lacerations are unusual unless there had been blows by batons over underlying bones or impacts against hard objects in falls, etc. Incised wounds too will be unusual, unless sharp weapons have been used and there had been a tussle for control of such a weapon. Another not uncommon cause of incised wounds may be from broken glass at the place of incident or arrest.

Fractures are rare but may occur from baton blows, falls and occasionally forceful twisting of an arm. Dislocation of shoulder joints too may occur.

It should be remembered that where chemical agents and/or other means of force had been used, specific injuries that may be associated with the use of these devices or agents should also be looked for their presence or absence documented clearly.

Ancillary investigations such as X-rays, toxicology, etc. should be done guided by the history of the incident available to the doctor.

Restraint at a Distance

One of the major problems facing police officers is how to restrain a violent or potentially violent individual, perhaps carrying an offensive weapon, using the minimum appropriate force. Clearly, the tactical firearms units are often required in these situations but there is an increasing trend to look for other "non-lethal" options, which will incapacitate with a lower risk of serious injury. Within the UK, the investigation of firearm incidents under the auspices of the Independent Police Complaints Commission with its attendant recommendations is a major influence at looking at developments in this area [23]. Different countries use different restraint equipment such as water cannon or the firing of different projectiles (e.g. bean bags) and these are subject to consideration for police use at certain times.

Baton Rounds

Relating to UK, these were previously known as plastic bullets, and are solid PVC cylinders measuring 10 by 3.7 cm fired from a shoulder held gun-like device. They were first introduced into Northern Ireland in 1970; 125,000 rounds have been fired and 17 fatalities have resulted, the last being in 1989. Deaths have usually been associated with direct hits to the head. Over time, the delivery systems have improved and this is reflected in the mortality figures. In June 2001, the L21A1 baton round was introduced to replace the "plastic bullet" in combination with a new baton gun and optical sight (L104 baton gun). This gives much better accuracy both decreasing the chances of dangerous inaccurate direct impacts, as well as avoiding hitting other persons than the target.

When used in situations of public order, they are fired at ranges between 20 and 40 m with the target being the belt buckle area. As an alternative to using firearms against those who may use firearms, or where there is major risk to life, the baton round can be used down to a range of 1 m. The aim is to hit the individual directly and not bounce the baton round before this, as this will cause both the projectile to tumble around its axes, making injury more likely, and decrease the accuracy of the shot. Injuries are mainly bruises and abrasions, with fewer lacerations, depending on how and where the body is hit. More serious injuries are possible with occasional fractures and contusions to internal organs. Although intra-abdominal injury is unusual, impacts to the chest can give rib fractures and pulmonary contusion.

A similar system is used in the United States based on the ARWEN (Anti-Riot Weapon Enfield) system, the Sage SL-6, and this is the preferred less lethal option of restraint. This has a projectile with a tail and is smaller and faster than the baton round. The pattern of injuries will be similar but if the projectile becomes unstable in flight so that the surface area striking the target is smaller (because of altered orientation), then the potential for injury is increased.

Bean Bag Rounds

Available widely in the United States, some Australian states, but not the UK, these consist of rectangular, square or circular synthetic cloth bags filled with lead pellets and fired from a shotgun. As an example, the "Flexible Baton" fires a bag containing 40 g of number 9 lead shot with a projectile velocity of around 90 m/s. At impact, projectiles are designed to have separated from the shotgun shell and wadding, opened out to strike the target with its largest surface area before collapsing as they lose energy. The effect is to provide sufficient blunt force from an ideal range of 10–30 m to stop an adult's progress.

In one study, De Brito et al. [24] reported that the commonest injuries were bruising and abrasions followed by lacerations without having retention of the actual bean bag. However, there are significant other serious injuries documented including closed fractures, penetrating wounds with retention of the bean bag projectile (and at times parts of the shell and/or wadding) and internal organ damage. Serious penetrating injuries involved the thorax, eye, abdomen and limbs. Thoracic penetration resulted in one fatality from a massive haemothorax. Blunt injuries included splenic rupture, pneumothorax, compartment syndrome, testicular rupture, subcapsular liver haematoma and cardiac contusions. It was noted that retention of the bag was not always suspected from an initial clinical examination, being detected on subsequent scans. The distance between gun and target was not formally examined in this study.

Clearly, this device has potential for significant trauma to anywhere on the body. Just as with other non-lethal alternatives for restraint, the forensic physician should always consider why such techniques were needed to be deployed; use of drugs or alcohol and psychiatric illness are all common concurrent problems in these situations.

Evaluations and Opinions

Doctors should wherever possible obtain as much information of an alleged incident as possible. Apart from the statements of the parties involved, in this modern age, photos and videos from surveillance cameras, on-lookers may be available. It is of course important to establish the credibility of these materials first before considering them.

Findings should be based on what is known. The doctor should be impartial, it is not the medical person's role to decide the appropriateness of a decision to use force or the degree of force, that is for the legal and public tribunal.

Summary

There exists an accepted but regulated need for law enforcement personnel to use force. Such use of force will and can cause injuries and sometimes death. Such incidents should of course be investigated in an open and transparent manner ensuring that all interested parties are properly represented. The impartiality of such investigative tribunals is the best safeguard to all members of society but must be built on trust [25].

Medical experts involved in such inquiries must be impartial and should keep up with the rapidly evolving literature. The exact or conclusive pathophysiology of such deaths have yet to be agreed and may never be agreed for each case is likely to be the cumulative effects of many things, some known and some unknown. Full autopsies must always be performed and toxicological analysis and interpretation sought. Full histopathological studies should be performed and where available newer molecular biological screenings for genetic markers of the heart, brain, etc. New theories based on physiological responses to stress may one day help us understand more the triggers for such deaths.

References

1. National Institute of Justice (2009) The use-of force continuum. http://ww.ojp.usdoj.gov.nij/topics/law-enforcement/use-of-force/continuum.htm
2. Reay DT, Holloway GA Jr (1982) Changes in carotid blood flow produced by neck compression. Am J Forensic Med Pathol 3(3):199–202
3. Ross DL, Chan TC (2006) Sudden deaths in custody. Humana, Totowa
4. DiMaio TG, Di Maio VJM (2006) Excited delirium syndrome – cause of death and prevention. CRC Press Taylor & Francis Group, Boca Raton
5. Glatten K, Karch SB (2004) Positional asphyxia: inadequate oxygen or inadequate theory? Forensic Sci Int 141(2–3):201–202
6. Raschka C, Stock A, Brunner K et al (1996) Changes of intracerebral blood flow during choking (shime-waza) in judo by transcranial Dopplersonography. Dtsch Z Sportmed 47:393–398
7. Parry SW, Richardson DA, O'Shea D et al (2000) Diagnosis of carotid sinus hypersensitivity in older adults: carotid sinus massage in the upright position is essential. Heart 83:22–23
8. McIntosh SJ, Lawson J, Kenny RA (1994) Heart rate and blood pressure responses to carotid sinus massage in healthy elderly subjects. Age Ageing 23(1):57–61
9. ACPO (2009) ACPO SDAR. Guidance on the use of handcuffs. Association of Chief Police Officers of England, Wales and Northern Ireland. http://www.acpo.police.uk/asp/policies/Data/Handcuffs_Guidance_Website.pdf
10. Rogers DJ, Stark MM, Davie M (1998) Medical complications associated with the use of rigid handcuffs: a pilot study. J Clin Forensic Med 5(1):34–37
11. Haddad FS, Goddard NJ, Kanvinde RN et al (1999) Complaints of pain after use of handcuffs should not be dismissed. Br Med J 318(7175):55
12. Stopford JSB (1922) Neuritis produced by a wristlet watch. Lancet 1:993–994
13. Stone DA, Laureno R (1991) Handcuff neuropathies. Neurology 41(1):145–147
14. Richmond PW, Fligelstone LJ, Lewis E (1988) Injuries caused by handcuffs. Br Med J 297(6641):111–112
15. Pollanen MS, Chiasson DA, Cairns JT et al (1998) Unexpected death related to restraint for excited delirium: a retrospective study of deaths in police custody and in the community. Can Med Assoc J 158(12):1603–1607
16. Neuman T (2006) Chapter 4. Positional and restraint asphyxia. In: Ross DL, Chan TC (eds) Sudden deaths in custody. Humana, Totowa
17. Chan TC, Vilke GM, Neuman T et al (1997) Restraint position and positional asphyxia. Ann Emerg Med 30(5):578–586
18. Schmidt P, Snowden T (1999) The effects of positional restraint on heart rate and oxygen saturation. J Emerg Med 17(5):777–782

19. Parkes J (2000) Sudden death during restraint: a study to measure the effect of restraint positions on the rate of recovery from exercise. Med Sci Law 40(1):39–44
20. Chan TC, Vilke GM, Clausen J et al (2002) The effect of oleoresin capsicum “pepper” spray inhalation on respiratory function. J Forensic Sci 47(2):299–304
21. Chan TC, Neuman T, Clausen J et al (2004) Weight force during prone restraint and respiratory function. Am J Forensic Med Pathol 25(3):185–189
22. Stratton SJ, Rogers C, Brickett K et al (2001) Factors associated with sudden death of individuals requiring restraint for excited delirium. Am J Emerg Med 19(3):187–191
23. Police Complaints Authority (2003) Review of shootings by police in England and Wales from 1998 to 2001. The Stationery Office, London
24. De Brito D, Challoner KR, Sehgal A et al (2001) The injury pattern of a new law enforcement weapon: the police bean bag. Ann Emerg Med 38(4):383–390
25. Coles D, Shaw H (2006) Comment: deaths in custody-truth, justice and accountability? Soc Justice 33:136–141

Chapter 8
TASER® Conducted Electrical Weapons

Mark W. Kroll

Introduction

John H. "Jack" Cover was the original inventor of TASER CEW technology. Mr. Cover was the Chief Scientist at North American Aerospace when it was the prime contractor for the National Aeronautics and Space Administration's (NASA's) Apollo Moon Landing program. Jack was a dedicated physicist who in the 1960s read about President Lyndon Johnson's Crime Commission report that urged the development of nonlethal weapons development to combat airplane hijacking, riots, and civil unrest. Jack's quest to develop his first CEW began in 1966 when he developed ECD working models and named them after his favorite childhood character: Tom A. Swift and his Electric Rifle (TASER). TASER CEWs are now used by over 15,000 Law Enforcement agencies worldwide that possess over 550,000 U. As of 1 June 2011, the devices have been used approximately 1.32 million times in the field and 1.25 million times in officer training. These numbers do not include the large numbers of times a CEW was used to resolve a violent encounter simply by its brandishing or by "painting" the suspect with the laser pointer sight.

Background

Operational Principles

A typical peak voltage of 1,900 V (volts) is delivered to the body by the TASER® X26™ CEW (Conducted Electrical Weapon) [1]. The average pulse voltage – which is what actually leads to stimulation – is actually about 600 V. *The CEW also*

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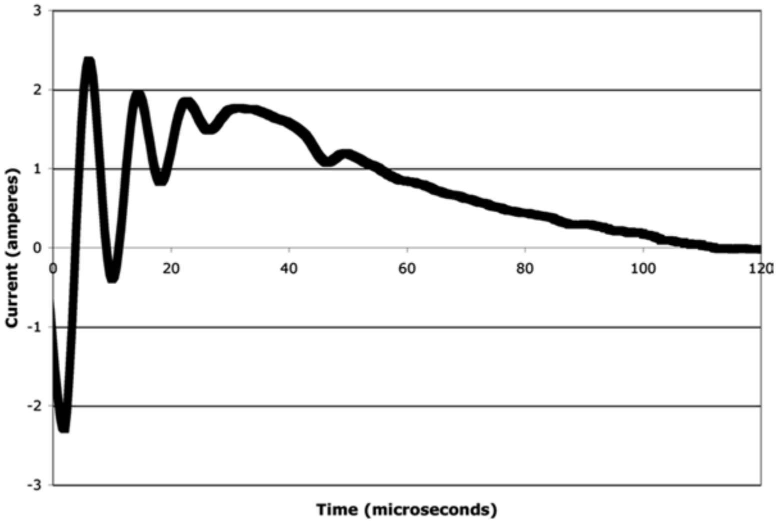

Fig. 8.1 Output waveform of X26 CEW pulse. Taken from a human probe application [1]. The initial short negative and positive peaks are the "arc" phase. They do not contribute to stimulation due to their mutual charge cancelation. The current delivered between 10 and 110 μs contributes to motor neuron and possible cardiac stimulation

generates an open-circuit (arcing) voltage of up to 50,000 V to arc through air or across thick clothing, but that voltage is never seen in, or "delivered" into the body. Briefly, the X26 CEW pulse generated is a specially designed short pulse with a duration of about 100 μs (microseconds) to efficiently capture alpha-motor neurons while having minimal cardiac effects. (These CEWs should not be confused with a generic "stun gun" which uses various high frequency electrical currents, over a short fixed-electrode current pathway, to cause discomfort or pain without any significant motor neuron activation that would cause skeletal muscle capture).

The typical X26 CEW electrical charge delivered is 100 μC (microcoulombs). The X26 CEW main phase charge (which determines muscle and cardiac capture) ranges from 50 to 100 μC depending on the connection quality. The X26 CEW average net current is approximately 2 mA (milliamperes) (=19 pulses per second × 100 μC). Figure 8.1 is a recording of a X26 CEW probe deployment into a human volunteer. The peak current is seen to be 2.4 A (amperes). What determines the capture (of both cardiac cells and motor neurons) is the electrical charge which is the area under the curve [2–4].

The TASER CEW delivers a rapid series of very short duration (10–110 μs) electrical pulses. Each pulse has less peak current than a strong static electricity shock that one could get from a doorknob on a winter day. Just as a strong static shock temporarily incapacitates someone, this series of 19 very short duration shocks per second delivered in probe-mode from the X26 CEW will likely temporarily incapacitate a person.

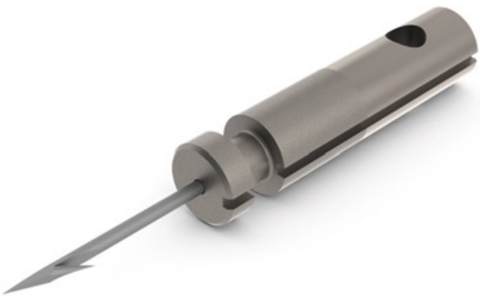

Fig. 8.2 CEW probe. The active portion is typically 9 mm long, but is also available with a 13-mm length. The active portion has a diameter of XX mm

In probe deployment mode, the TASER M26™ CEW, X26 CEW, and X2™ CEW use compressed nitrogen to fire two small probes at distances up to 7.7 m (25 ft). TASER cartridge models are available to reach out to 11 m (35 ft) as well. These probes, which are designed to pierce or become lodged in most light clothing, are discharged from the cartridge at a velocity of approximately 60 mps (meters per second) (200 feet per second) and can penetrate the body to a depth of no more than 13 mm (Fig. 8.2).

The TASER M26 CEW delivers damped sine wave current pulses with a fundamental frequency of 50 kHz (kilohertz). The main phase has a peak current of about 13 A and an average pulse current of about 8.5 A. *The M26 CEW output voltage will vary with contact impedance and may exceed 50,000 V to arc through air or clothing when the probes are not directly contacting the body; it drops to a delivered voltage of about 5,000–8,000 V when contact and delivery of charge is made.* The first, main cycle (or primary phase) is about 10 μs long and delivers the charge to cause the A-α motor neuron capture. The charge in this phase is about 85 μC. The other phases do not appear to contribute to the motor-nerve-mediated stimulation of muscle contraction, but actually cancel some of the effects of the principle phase especially for cardiac stimulation. In fact, the M26 CEW "net" charge (of 40 μC) is the best measure for predicting cardiac stimulation [5].

The newest TASER CEW is the X2 CEW model. The X2 CEW delivers up to two probe pairs from a single cartridge. The pulse duration lies between that of the M26 CEW and X26CEW. The X2 CEW delivers a peak current of 1.7 A. The X2 CEW delivers a typical main phase charge of 63 μC (see Table 8.1).

Selective Nerve Stimulation

The stimulus train of narrow pulses applied (in probe deployment mode) is intended primarily to capture the motor neurons and cause the nerve-mediated activation of skeletal muscle contraction (thus disabling the target individual through incapacitation of their ability to voluntarily move and to stand). It will also elicit strong sensory overload and discomfort. An important safety concern of the electrical weapon technology is to significantly minimize or eliminate stimulation of the heart, which could cause life-threatening arrhythmias or cardiac arrest.

Table 8.1 TASER CEW electrical characteristics table

Electrical output characteristic	X26	M26	X2
Waveform	See Fig. 8.1	50 kHz damped oscillation with a 17-μs decay time constant	Same shape as X26 but lower current and duration
Pulse rate	19 pps (pulses per second)	20 ± 25% pps with NiMH rechargeable cells 15 ± 25% pps with alkaline cells	19 pps
Pulse duration	110 μs	40 μs full waveform 10 μs main phase	80 μs
Voltage – peak	1,900 V	8,000 V	1,020 V
Voltage – average over duration of main phase	580 V	5,400 V	500 V
Voltage – average over 1 s	1.2 V	1.1 V	0.75 V
Electrical charge – main phase	110 μC, 102 μC net	95 μC, 40 μC net	63 μC
Current – average over 1 s	2.3 mA (average rectified current) 1.9 mA current from main phase which is a better estimate of stimulation capacity	3.6 mA (average rectified current) 1.9 mA current from main phase	1.35 mA (average rectified current) 1.25 mA current from main phase
Pulse current (delivered during pulse)	1.0 A average 3.1 A peak	8.5 A average current during 10 μs main phase 13 A peak	0.83 A 1.7 A peak
Energy per pulse	0.10 J	0.50 J	0.07 J
Power (relevant to heating but not stimulation)	1.9 W (watts)	10 W (at 20 pps)	1.0 W
Battery	Two 3 V lithium cells (Duracell® Ultra, CR123A)	8 – AA NiMH® cells (1.2 V per cell) 8 – AA Alkaline cells (1.5 V per cell)	Four 3 V lithium cells (Duracell Ultra, CR123A)

Values shown are typical. For readability, specification tolerance ranges are not shown

By comparison to motor or sensory myelinated nerves, the heart's excitability (as in pacing of the heart) is relatively low for brief stimuli. This is because the minimum (rheobase) level of charge needed for stimulation is much higher for cardiac cells than myelinated nerves [6]. Since the cardiac strength-duration time constant is about 10–20 times higher than the A-α motor neuron fibers which control skeletal muscle contraction, the safety margin declines significantly for wider pulses. The heart is also located deep within the torso (as opposed to the skeletal muscle which comprises much of the superficial layers of the torso and into which electrical weapon probes may penetrate if they embed just below the skin). Thus, relatively little, if any, current will pass through the heart. This effect of relatively low penetration of the electrical charge into the heart given surface or near-surface stimulation of tissues is well known and well studied both in the electrical safety literature as well as the medical literature of transthoracic pacing and defibrillation.

In general, skeletal muscle activation by electrical stimulation is elicited by excitation of A-α motor neurons which innervate such muscle fibers. This fact often comes as a surprise, in that skeletal muscle cells are themselves excitable. In bioelectricity, the "rheobase" is defined as the stimulus charge necessary for capture by very short pulses. The "chronaxie" is the stimulus duration at which 2× (twice) the rheobase charge is required. (The rheobase and chronaxie are also commonly defined by current instead of charge.)

Excitability of skeletal muscle, per se, is far less than that of their motor neuron cells in that both rheobase and chronaxie values of skeletal muscle are higher than those of the myelinated nerve axons which innervate them. Thus, there is essentially zero direct activation of skeletal muscle cells. Sensations of discomfort, sensation overload, and pain in response to electrical weapon stimuli would be expected to result from a host of sensory nerve fiber types, to some extent dependent upon the specific locations of electrical weapon probe attachment to the body (as well as the specific tissues located between and near the probes in what might be called the "capture" zone of the probes where excitable cells are likely activated).

From both efficacy (in terms of efficiently activating skeletal muscle between and near the probes) and safety (in terms of nerve-mediated activation of skeletal muscle with a wide safety margin in comparison to corresponding current levels that would be needed to excite or fibrillate the heart) viewpoints, the CEW stimulus pulses appear to selectively stimulate muscle controlling motor neurons more than the heart.

The duration of the X26 CEW stimulus pulse is on the order of the strength-duration time constant τ (and chronaxie) for electrical excitation of the A-α motor neuron fibers, making it an effective stimulus in terms of pulse duration. It appears likely that reflex activation of additional skeletal muscle response may also occur through excitation of motor afferent myelinated nerves. Skeletal muscle not contained within the "target" zone of the electrical weapon probes might also be activated if motor afferent or efferent nerves are stimulated which then innervate more distant musculature (as in the instance where nervous structures within or entering or leaving the spinal cord might be excited).

The very short duration of the X26 CEW pulse is also likely to result in widespread excitation of cutaneous myelinated nerves responsible in normal function for senses of touch, pressure, vibration, pain, and temperature. There is a modest separation of the duration of the X26 CEW pulse (110 μs in duration) in comparison to the time constant values for excitation of the type III A-α myelinated nerve fibers responsible for "sharp" pain (τ equal to about 150 μs) as well as for activation of C fibers responsible for dull or aching pain ($\tau \sim 500$–600 μs). The subject of the nature and qualities of sensory perception through electrical stimulation is also well studied; of note is the qualifier that perception is known to vary when stimulation is compared to normal sensation where the (presumably) same nerve fibers are activated. Sensation with electrical stimulation tends to be "less natural," and more difficult to describe, and is often perceived as "overwhelming" due to the unnatural simultaneous sensory nerve activation. C fibers also have notably higher thresholds (in terms of rheobase electric fields necessary to stimulate) than myelinated motor or sensory nerve fibers.

Drive-Stun

The TASER CEW should not be confused with generic "stun guns." Generic stun guns deliver less average current (typical values of 0.3–0.5 mA) and deliver it over a short pathway between two fixed electrodes. The result is isolated pain, but they lack both the electrical charge and the electrode spread to cause motor neuron activation and skeletal muscle capture. With stun gun electrodes only 2–5 cm apart – and the lack of skin penetration, the current flow is primarily across the epidermis and then *along* the dermis between the electrodes and there is no significant penetration beyond the fat layer. Thus, there is insufficient current in the skeletal muscle layer to capture motor neurons and achieve muscle control.

However, the live probe cartridge can be removed, or with a discharged cartridge in place, and the CEW used in a "drive-stun" mode by pushing the front of the CEW into the skin to function as a higher charge stun gun. Since there is insufficient electrode spread (4 cm) to capture muscles, the drive-stun mode primarily serves only as a compliance technique. The newer X2 CEW can deliver a drive-stun without live cartridge removal.

Electrical Outputs

Safety Standards

It is helpful to discuss the most common and longest existing electronic control devices that control humans and other mammals by giving short painful electrical stimuli – namely electric fences.

Table 8.2 Characterization of effects of various charge shocks

Physiological effects by IEC 479-2	Single pulse levels by IEC 479-2 (μC)	Repeated pulse levels by standard correction (μC)
Slight	200	20
Painful	2,000	200
Dangerous but VF unlikely	20,000	2,000
Dangerous and VF likely	200,000	20,000

Both the IEC (International Electrotechnical Commission) and UL (Underwriters Laboratories) have long had standards for electric fences [7, 8]. These are the Particular Requirements for Electric Fence Energizers: IEC 60335-2-76, edn 2.1 and the UL Standard for Electric-Fence Controllers in UL 69. Independent testing has verified that the TASER M26 and X26 CEWs satisfy both the IEC and UL electric fence standards [9].

The IEC standard 479-2 includes safety levels for electric charge [10] (see Table 8.2 based on page 38 of this standard which deals with an electrode on the human trunk). Interested readers will find that the actual table uses the term "specific charge" and the units are in terms of "As" (ampere-seconds, or coulombs). The standard is based on a single short pulse while the CEW delivers a series of short pulse. The standard accepted correction for a long train of repeated pulses is to divide the single pulse level by 10 [11]. It is seen that repeated pulses of 200 μC are considered painful but safe and even 2,000 μC unlikely to induce VF. The IEC standards are based on surface contact. If a probe were to be fully embedded in the intercostal spaces over the heart in a very thin person so that the probe tip was within about 1 cm of the epicardium, these large safety factors are decreased.

Common Myths

50,000 V

The average X26 CEW pulse voltage is actually only about 600 V [12]. The CEW also generates an open-circuit voltage of up to 50,000 V to arc through air or across thick clothing.

It is certainly not intuitively obvious how a 50-kV (kilovolt) pulse can pass through clothing, but then not pass through the body. The technical reason is that the clothing has a very high impedance (nearly infinite) while the body has a much lower impedance (on the order of 600 Ω (ohms)). In addition, the 50 kV pulse is generated by separate output circuitry from that of the 600 V pulse. The 600-V pulse is generated by a direct connection of charged capacitors which deliver a fixed charge to the body. The 50 kV pulse is generated by a high-impedance transformer output which has low current capacity. An analogy is the Van-de-Graff generator which delivers a high voltage – but low current – arc. While impressive, it cannot power a simple lantern while a high current – but low voltage – 1.5 V cell can.

While incapable of stimulating muscles, the "impressive" nature of the arc and the natural fear of electricity adds a significant additional capability to the CEW. LEOs (law enforcement officers) in the United Kingdom have found that the mere display of the arc is enough to gain volitional subject compliance in the majority of cases [13].

Pacemaker Patients

Pacemakers and ICDs (implantable cardioverter defibrillators) are required by international standard to withstand the 360 J (joule) shock of an external defibrillator, lasting approximately 10 ms (milliseconds), and protection circuits have been incorporated to prevent damage to electronic components from transthoracic shocks [14]. The X26 CEW delivers about 0.1 J per pulse. Thus, pacemaker and ICD protection circuits have ample safety margin to protect against X26 CEW discharges. Nevertheless, transthoracic defibrillation shocks can reprogram and occasionally damage pacemakers if a defibrillation electrode is placed directly over the pulse generator. However, no investigators have identified reprogramming of or damage to pulse generators as a result of CEW discharges [15–17]. Ironically, the very protection circuits that prevent damage to the pacemaker itself can facilitate parasitic pacing as discussed later.

In ICDs, rapid oversensing long enough to fulfill the programmed VF (ventricular fibrillation) detection duration results in inappropriate detection of VF. Haegeli et al. reported such a case in a 51-year-old female ICD patient with an "integrated bipolar" lead [16]. Such a lead is more sensitive to interference compared to the "true bipolar" lead [18]. Probes struck the woman in the sternum and the pulses were mistaken by the ICD as VF. The ICD began charging its capacitors to deliver a shock. By the time the capacitors were charged, the CEW application was over and the ICD then went back to normal monitoring operation without delivering a shock.

Cao et al. reported a case of X26 CEW cardiac capture in which the CEW discharge was delivered into the chest of a rioting prisoner with a pacemaker [15]. The specific pacemaker involved had the typical overvoltage protection circuitry that passes negative potentials from the can (pacemaker housing) to the intracardiac bipolar ring electrode which can cause unipolar cathodal pacing [17]. A 53-year-old male had a dual-chamber pacemaker (Medtronic Kappa, model KDR901). This caused cardiac capture (~220 BPM) for the duration of the CEW pulse, but had no lasting effects. FEM (finite element modeling) in this case indicates that the CEW field at the heart was much weaker than the stimulation threshold, but the field at the pulse generator was likely sufficient (5–10 V) to permit capture after being channeled to the ring and tip electrodes [19]. This current pathway has the potential for ventricular proarrhythmia, but the level of risk does not appear to be great as a sustained arrhythmia has yet to be documented in such a case.

CEW interactions with pacemakers and ICDs are infrequent due to the significant differences in the demographics between the typical resisting subject requiring CEW control methods (30 ± 10 years) [20] and pacemaker patients (first implant 75.3 ± 11.1 years) [21]. ($p < 0.0001$) TASER brand CEWs have been used an estimated 1,350,000 times in the field (1 July 2011) with only a handful of reported pacemaker and ICD patients as the recipients of the application [22].

The most common ICD-CEW interaction is detection of the CEW pulses as rapid oversensing, which should put the pacemaker into noise reversion (fixed-rate) mode for the duration of the application. This should prevent syncope in the pacemaker-dependent patient. For an ICD patient, oversensing of CEW pulses may result in inappropriate detection of VF. There is a risk of an ensuing shock delivery, but as discussed earlier, this is unlikely because the typical CEW application is shorter than the typical ICD detection and capacitor charge times.

Illegal Stimulants

Since common illegal drugs are dangerous in so many ways, some are tempted to inappropriately assume that the drugs must also be synergistically dangerous for electrocution. In fact, the opposite is often true. For example, cocaine intoxication actually makes a person *more difficult* to electrocute.

It is well documented that cocaine has strong effects on the heart such as dramatically raising the heart rate and blood pressure [23]. Chronic cocaine usage also significantly increases the risk of a myocardial infarction [24] and cardiac arrest [25]. Thus, the natural, although incorrect, "medically intuitive" assumption is that the presence of cocaine also makes it easier to electrocute someone (i.e., electrically induce VF). What is surprising – even to some cardiologists – is that this *natural* assumption is wrong. Most scientific studies have shown that cocaine makes electrocution more difficult – not easier [26–28]. This is due to the sodium channel blocking effects of cocaine which makes it much harder to stimulate a heart cell.

This has been confirmed using actual X26 CEW waveforms [29]. The VF safety margin went up significantly with the presence of cocaine and was almost doubled for barbs near the heart.

Cardiac electrophysiologists (EPs) routinely use intravenous stimulants (such as isoproterenol) to help induce ventricular tachycardias in their electrophysiology labs. Hence, a typical first blush reaction is to assume that stimulants increase the risk from a CEW or external electrical shock in general. However, stimulants – including isoproterenol – tend to actually increase the amount of electrical current required to induce arrhythmias [30]. The same is true with other stimulants such as phenylephrine [31].

This apparent contradiction stems from the fact that EPs use strong enough pacing pulses (in the electrophysiology lab) directly delivered to a tiny spot on the inside of the heart. So, the decreased sensitivity to electrical stimulation from an adrenergic stimulant is irrelevant in the EP lab – it is trumped by the highly focused and concentrated *internal* electrical current delivery. However, this same decreased sensitivity (from adrenergic stimulants) makes externally applied electrical currents much safer. In general, stimulants actually increase the safety margin for externally applied electrical currents, such as by CEWs.

A direct catecholamine (internal stimulants) challenge of epinephrine and norepinephrine appears to only lower the VF threshold (VFT) for the first 3–7 min – which in an ARD (arrest-related death) is usually *before* the arrival of law enforcement and EMS (emergency medical services) to a call for strange or bizarre behavior, after which time the VFT actually goes up [32]. Thus, this person, ironically, is probably safer from electrocution than the responding LEOs and EMS personnel once they arrive on the scene.

Note that this field CEW application situation is far different from someone quickly ingesting a large drug dosage in front of LEOs and then struggling against the officers' attempts at capture, control, and restraint. That could be dangerous with some stimulants for the first few minutes as was shown in an absolute worst case situation of low body weight, barb inserted under the skin, barb placed over the heart, barb penetrating the intercostal muscles, and a strong pure stimulant (epinephrine – with no protective effects such as those of cocaine) given intravenously [33].

With the methamphetamine epidemic, there is concern that drug abusers using this and other illegal stimulants could be at increased risk for electrocution from the CEWs. However, a small animal study found no CEW-induced VF even in the presence of various similar stimulating agents [34]. Also, the large study from the UK (United Kingdom) Home Office found no increase in risk with common drugs [35].

In a sheep study, methamphetamine possibly raised the cardiac capture threshold as capture was noticed with the X26 CEW before the methamphetamine administration. Afterwards no cardiac capture was possible with probe locations directly over the heart [36].

Epidemiology

TASER CEWs have now been applied to over 2.6 million human beings with a roughly evenly split between suspects and LEOs in training as shown in Fig. 8.3. There are now several papers on the epidemiology of suspect injuries. A summary of these studies is found in Table 8.3. Eastman et al. did a prospective study of 426 CEW uses in Dallas, Texas. He found 0 suspect injuries (beyond scrapes and cuts requiring only first aid). Notably, he found that in 5.4% of the CEW uses, lethal force was replaced by CEW use. Bozeman et al. prospectively studied 1,201 uses in 5 law enforcement agencies in the USA. There were 2 serious injuries from falls at a rate of 0.17%. One was a 6.5-mm temporoparietal intraparenchymal contusion and the other an 8-mm cerebellar epidural hematoma. Both subjects were admitted to the hospital for observation and discharged after 2 and 3 days without neurosurgical intervention or long-term sequelae. There was a case of rhabdomyolysis which was discussed in detail in the paper and was clearly unrelated directly to the CEW usage.

In the Bozeman study, there were 2 deaths:

> Both cases were men in their 30 s who struggled violently with police both before and after conducted electrical weapon use and on whom other physical force was used to take them into custody. One subject had a high body mass index and was involved in a foot pursuit and prolonged physical struggle with police, during which 2 conducted electrical weapon. dis-

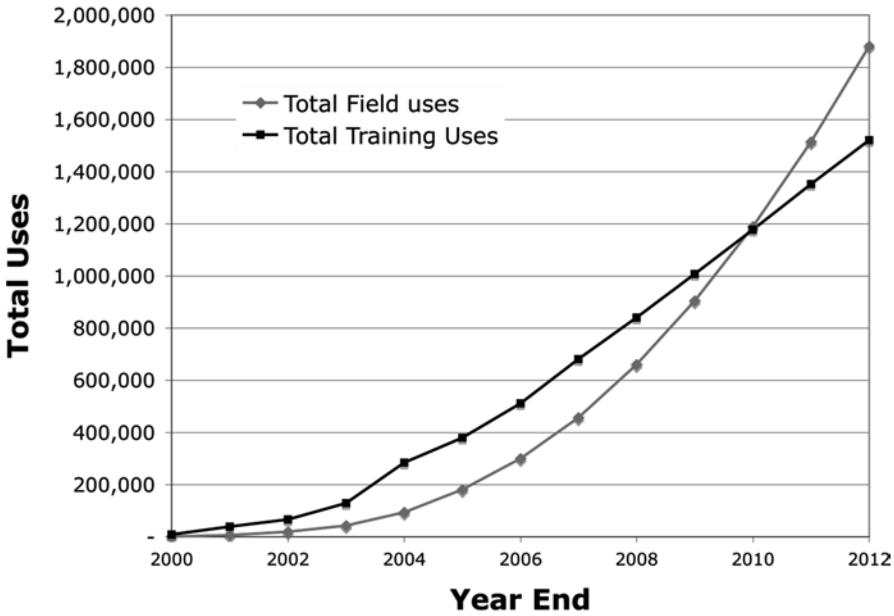

Fig. 8.3 Total CEW field and training exposures. Values for 2010–2012 are model-based predictions

> charges were used. He collapsed approximately 20 minutes later. At autopsy, he was found to have a dilated cardiomyopathy and cocaine was present in the serum. The second subject was agitated and violent, with a history of mental illness. After an extensive struggle, during which pepper spray and 2 conducted electrical weapon discharges were used, he was restrained in a prone position. He collapsed an estimated 5 minutes after conducted electrical weapon use. An autopsy revealed no anatomic cause of death, but olanzapine at 170 ng/mL was present in the serum. Conducted electrical weapon use was not determined to be causal or contributory to death by the medical examiner in either case.

Strote et al. studied 1,101 consecutive uses by the Seattle Police Department, Washington, USA. He found 8 "restraint related" trauma injuries. However, he did not distinguish the injuries typical of CEW usage (e.g., head injury from fall) from those typical of other control techniques (broken limbs, dislocations, etc.). Thus, the Strote study is not helpful for estimating CEW rates except to place an extreme upper bound at 0.73%, which is far higher than the combined rate of 0.12% from the Eastman and Bozeman studies ($p = 0.04$ by chi-square). The UK Home office publishes statistics on CEW usage quarterly [37]. As of November 2009, they had 1765 actual field CEW applications of current to suspects (thus not counting displays and arcing). There were no deaths blamed on the CEWs. Unfortunately, the injury rate has not been publicly reported.

Smith et al. did a cross-over analysis of CEW usage in Richland County (South Carolina, USA) and the Miami Dade (Florida, USA) police department. They found that the Miami data showed an 87% reduction in suspect injuries and a 68% reduction in officer injuries. Results for smaller Richmond County did not reach statistical

Table 8.3 Suspect injury and fatality rates

First author	Years	Exposures	Exposure duration	Significant trauma from CEW	Deaths	Notes
Eastman [20]	2004–2006	426	8.6 ± 5.9 s	0	Single death from cocaine	
Bozeman [40]	2005–2008	1,201	1.8 exposures	Head trauma from falls (2)	Two deaths ruled unrelated to CEW	Single case of rhabdo-myolysis in cocaine user running on hot day
Strote [156]	2001–2006	1,101	1.7 exposures	Not reported	0	Study reported 8 hospital admissions for restraint-related trauma. No breakdown given of CEW-related injuries
Home office [37]	2004–2008	1,765		Not reported	0	
Summary		4,493			0	

Table 8.4 Suspect and officer injury rate impact

First author	Suspect injury reduction (%)	Officer injury reduction (%)	Notes
Smith [157]	87	68	Numbers are for MiamiDade County. The smaller Richland County data did not achieve statistical significance
Brewer [158]	64	63	Includes self-reported agency data
MacDonald [38]	65	0	

significance. Brewer et al. performed a weighted meta-analysis of reductions in suspect and officer injuries in the first full year of a law enforcement agency adopting the CEW. They found that the suspect injury rate was reduced by 64 ± 12%, while the officer injury rate was reduced by 63 ± 8%. The USA DOJ (Department of Justice) research arm NIJ (National Institute of Justice) sponsored a combination cross-over and a case-control study of the impact of CEW adoption by MacDonald et al. [38]. They studied 12 agencies and found suspect injury reduction of 65%, but no officer injury reduction (Table 8.4).

Finally, a curious paper must be discussed. Lee et al. asserted that the ARD rate actually went *up* in the first year after CEW deployment and then returned to normal [39]. This paper failed to give actual numerators and denominators (disclosing only percentages) and the authors have declined to share any of their data with other researchers. The speculated mechanism for the unusual finding was that overly aggressive use of the CEWs in the first year would escalate the violence in an arrest situation and lead to more officer-involved fatal firearms shootings. That speculated mechanism is inconsistent with all other research in this area. For the above reasons, the credibility and influence of this paper are generally considered to be low.

Morbidity

Probe Wounds

Probe Mark

The probe impact leaves a very distinctive disc-shaped mark of ~3 mm diameter. Figure 8.4 depicts this postmortem. Obviously, in a living person the inflammation and healing process continues. This is shown in Fig. 8.5 for 24, 48, and 96 h postexposure. Complete healing and recovery of normal skin appearance may take a month. In addition to the initial wound, the small puncture wound from the shaft of the probe itself may be visible as shown in Fig. 8.6. The above will be seen where the probe actually penetrated the skin and the thicker collar impacts the skin.

Fig. 8.4 Postmortem CEW probe wound. Other wounds were from violent prolonged struggle

In about 20% of cases, one of the probe connections is made by arcing through thick or baggy clothing. In that case there will be no characteristic disc mark, but rather a slight burn from the arcing current. This response is more obvious in darker skinned individuals.

Ocular Injury

The head, face, and neck receive 1.4% of probe landings [40].

The sharp probe clearly carries a risk of injury to the eye should direct contact occur. There have been a handful of published case reports with the typical level of injury being a blind pinpoint spot in the affected eye [41–43]. A recent case study suggested that an individual developed a cataract in his left eye as a result of a CEW application to the face, even though there was apparently no probe penetration of the eye [44]. (The authors did not provide details of the weapon model used, mode of application, or location of application beyond stating that it was on the face.) It is unclear whether or not the cataract was present previous to the CEW

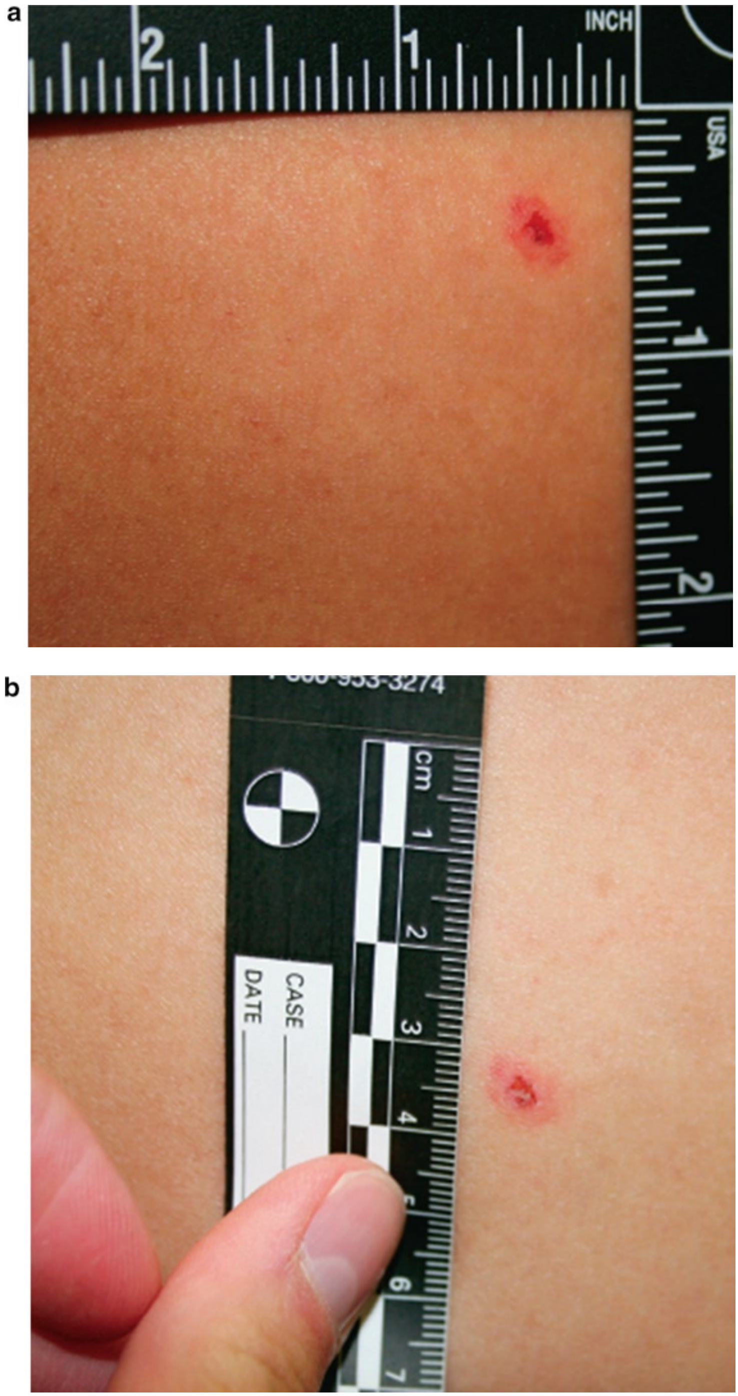

Fig. 8.5 CEW probe wounds. (**a**–**c**) are respectively 24, 48, and 96 h postexposure

c

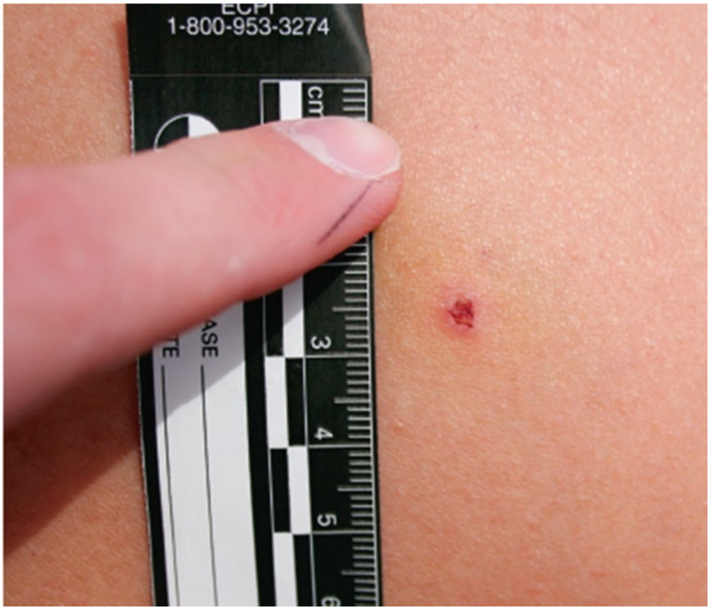

Fig. 8.5 (continued)

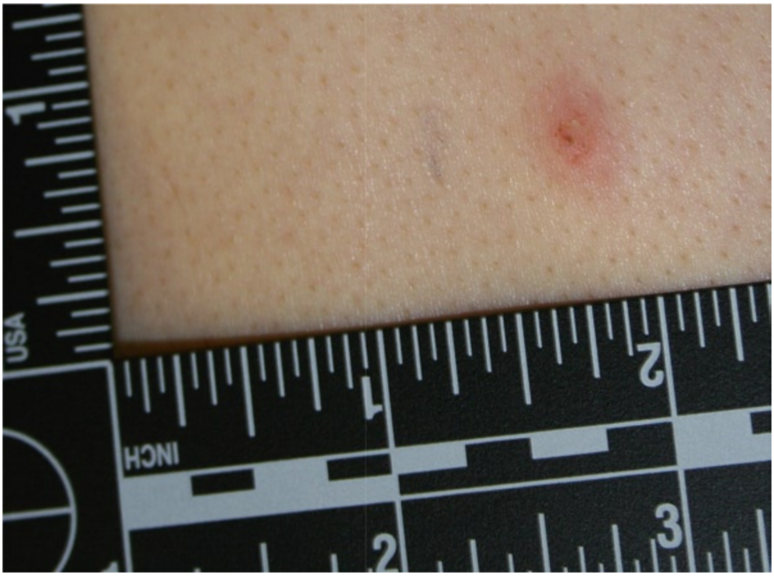

Fig. 8.6 CEW probe wound 24 h postexposure in which the small dart puncture wound is noticeable

application. The right eye had injury as well, which the authors attributed to blunt trauma. The report did not specify whether or not the individual had any previous visual acuity problems. In addition, the patient was lost to follow-up. In summary, the issue of the possibility of a CEW-induced cataract should be considered unresolved.

Skull Penetration

The penetrating part of the probe is either 9 or 13 mm long. This is sufficient to penetrate the skull and the energy in the probe is sufficient to drive this penetration with a hit perpendicular to the surface of the skull. There have been two published case studies and the author is aware of another unpublished case [45, 46]. There were no infectious or neurological sequelae. In one case the broken-off probe tip was left in the outer cortex [45, 46].

In another case, an officer chasing a suspect was accidentally shot in the back of the head by his partner [47]. He quickly fell to the ground and had loss of consciousness, clonic-tonic seizure activity, and postictal confusion. It is difficult to apportion blame between the possible electrical stimulation and the brain trauma from the fall.

Pneumothorax

A pneumothorax was reported in a case involving a 16-year-old suspect who received a probe into his left chest while attacking an officer [48]. He was 180 cm tall, weighed 66 kg giving him a BMI (body mass index) of 20.4 kg/m^2. The probe was removed in the hospital; he was treated for the pneumothorax and was discharged in 2 days. However, it was not clear to the authors that there was a direct penetration. It may have been a secondary pneumothorax from a strong valsalva leading to high pressures.

Vertebral Fracture

Cases of vertebral compression fracture have not been reported in field use on suspects. However, there have been published case reports of compression fractures in LEOs in training exposures across the back [49, 50]. In at least one case, the officer had preexisting osteoporosis. In another case, a LEO had preexising osteopenia. These case reports, out of 1.3 million training exposures, suggest an injury rate that compares favorably to jumping sports such as basketball. Additionally, it is believed that the compression fractures are caused by the person coming violently forward after the completion of the CEW exposure. This is suspected because the compression fractures are anterior and not posterior fractures. When a subject receives a back exposure to the CEW, he arches backward, not forward. Thus, if the CEW discharge was the direct cause of the fracture, the fracture should be posterior and not anterior. No posterior fractures have been reported.

Fall Injuries

The design objective of the CEW is to cause a violent person to lose control of some major muscles in order to stop resistance. A standing suspect will suffer a sudden and uncontrolled fall with all of its obvious risks. The typical fall-related injuries (varying with ground surfaces) are to be expected. This includes lacerations, bruising, hematomas, dental damage, and limb and skull fractures. Bozeman et al. reported 2 significant head traumas from CEW-induced falls; Mangus et al. reported on 3 such injuries [40, 45].

Drive-Stun Burn Marks

As mentioned earlier, the CEW may also be used in the "drive-stun" mode sans probes and cartridge. The effect of this mode is localized pain to encourage compliance with officer commands. The characteristic sign is a pair of burn marks about 4 cm apart corresponding to the 4 cm electrode spacing on the muzzle of the weapon, or the exposed electrodes on a previously discharged cartridge. An example of such a pair of marks is given in Fig. 8.7. Due to suspect-movement, there are often scratches (which may be paired or unpaired) associated with the metal electrodes on the weapon. What is somewhat surprising is that drive-stun applications may cause more skin trauma than do the probe-mode applications. The fully penetrated probe forms a low resistance path and hence there is minimal heating at the skin. The drive-stun application, on the other hand, must cope with the high electrical resistance of the epidermis, which leads to some burning. This is shown in Fig. 8.8. Additionally, the act of "driving" the CEW into the subject (applying with high force to improve electrical contact) and the subject's movements increases the obvious trauma to the skin. With such movement, a single 5-s CEW cycle can result in numerous skin contacts and resulting damage.

Burns from Ignition of Flammable Substances

As discussed later under Mortality, the spark – from a CEW *failing* to make a good connection – can ignite flammable gaseous substances. This has occasionally led to serious injuries. In some cases, however, there was concomitant alternative source of spark present.

Fig. 8.7 Drive-stun marks. (**a**–**c**) are respectively 0, 24, and 72 h postexposure

Case Study

Police say they used the [CEW] on Ronald Mitchell, 36, when he ran at them carrying a container of petrol and a cigarette lighter. They said that Mr Mitchell, who lives in a remote Aboriginal community, had been sniffing petrol. They suggested c

Fig. 8.7 (continued)

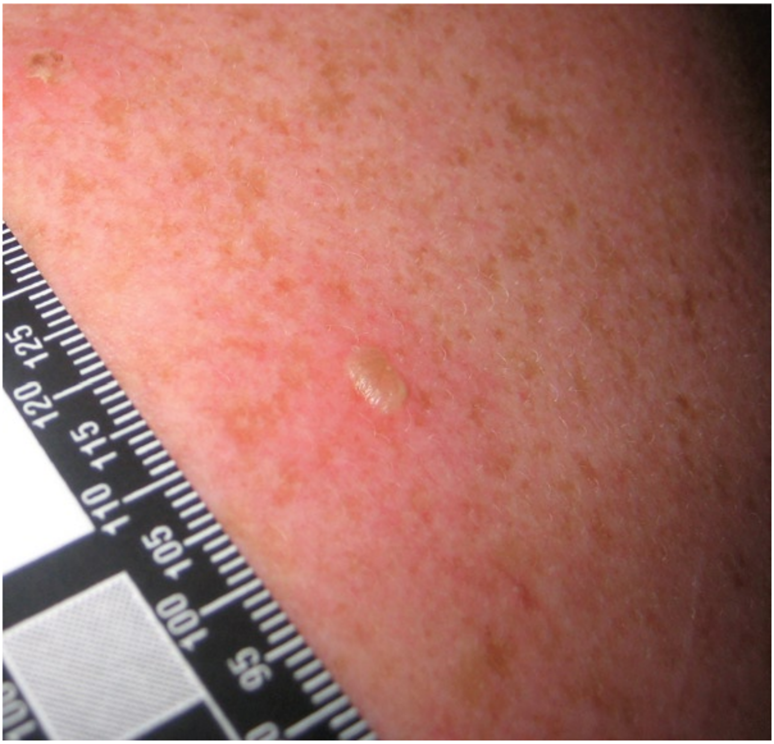

Fig. 8.8 Example of drive-stun blistering

the cigarette lighter started the fire. Mr Mitchell is in a critical condition in hospital with third degree burns. Western Australia Police used the [CEW] on Mr Mitchell when he came out of the house and ran at them. He burst into flames. One officer pushed him to the ground and smothered the fire with his bare hands, police said. Mr Mitchell's sister told The Australian newspaper that her brother had been sniffing petrol. "He must have put petrol on his face, then the policeman shot him with the [CEW], that's when the flames happened," she said [51].

Speculated But Unsupported Morbidities

There have been a number of speculated potential morbidities associated with the CEW. Suspects presenting with excited delirium type behavior tend to have rhabdomyolysis and acidosis. Many also have cardiomyopathies from their chronic abuse of cocaine, methamphetamine, or alcohol [52–54]. Hence, there has been concern that CEW application could cause or exacerbate any of these conditions. These issues have been studied extensively in both animals and humans and the CEW has been shown not to cause or contribute to these conditions.

Animal and clinical studies find only minor increases in myoglobin or in CK (creatine kinase) [55–57]. The CK level increases were consistent with moderate exercise. A meta-analysis of 5 human studies included CEW exposure times of 5, 10, and 30 s [58]. The median preexposure level was 145 (Inter-quartile range 104–217). Median increases in CK (at 24 h postexposure were, respectively, 26.5, 303, and 47). A recent multicenter study also found no clinically significant increases in CK [59]. Thus, it does not appear that CEW applications can cause clinically significant rhabdomyolysis.

Acidosis has been reported from CEW applications in swine studies, However, the ventilated and anesthetized swine had the ventilator turned off during the CEW application [55, 60, 61]. Human beings continue to breath well during CEW applications whether across the chest, diaphragm muscles, or phrenic nerves in the neck [62–66]. This suggests that the unventilated anesthetized swine model does not give meaningful predictions extrapolatable to humans for acidosis. In fact, human studies find a minor pH shift with the CEW application similar to that seen with moderate exercise. Randomized studies have shown that a 10-s CEW application reduced acidemia in the already exhausted volunteer compared to the alternative of continued exertion from physical control techniques [67, 68].

By denying the agitated subject muscle control, the CEW application may reduce metabolic demands compared to the intense exercise of a struggle. This has been evaluated in humans with CEW exposures up to 30 s.

Massive electrical shocks, such as those from lightning or power lines, can cause cardiac cellular damage as evidenced by increased troponin levels [69]. Troponin levels have been measured in subjects before and after CEW exposures in numerous studies [57, 59, 65, 68, 70]. No statistically or clinically significant increases were found. A recent "best-evidence" review concluded that no cardiac monitoring was required for subjects in sinus rhythm after a CEW exposure [71].

A sharp blow over the heart can induce VF via the mechanism of commotio cordis [72]. This is associated with energy levels of 380 J (rubber bullet) or 540 J with a plastic bullet. Rarely, but tragically, it is reported in young people with a 13-J impact over the heart during the T-wave. This has been suggested as a possible injury (or mortality) mechanism from a CEW. However, the CEW probe kinetic energy (1.5–2.2 J) is far too low to induce commotion cordis [73–75].

Injury Treatment

The most common CEW injuries are those related to falls and those are treated in typical fashion [76]. However, there are specific concerns regarding the probes themselves and these are discussed below.

Probe Removal

Ordinarily, probe removal requires no special skills or training. LEOs commonly remove the probes without problems. In fact, criminal suspects often happily volunteer to remove the probes themselves if their hands are free. It is a common practice to apply a topical antibiotic to the puncture or burn site. While there is no data supporting this approach directly, there do not appear to be contra-indications.

In the event of either a skull or ocular penetration, the removal clearly must be left to qualified clinicians. In many jurisdictions, policy requires a medical professional for probe removal and evaluation after each CEW usage – regardless of anatomical location. Due to the demonstrated low injury rate of CEWs, these policies appear to be driven more by overly-conservative legal than medical rationale. In the case of excited delirium behavior, prompt medical intervention is required, not as a result of the CEW, but this is a medical emergency presenting as a psychiatric problem [77].

Probe Infection

Due to the 9 or 13 mm possible probe penetration depth and the lack of sterilization, infection is a common concern from a probe deployment. However, with well over one million human probe penetrations, there has never been a case of infection reported in the literature. The author is aware of a mild skin infection from a drive-stun application, and one litigation where serious infection is alleged

The factory-shipped probes have some micrococcus on them, but no other bacteria have been found. It is theoretically possible that a probe might carry skin surface contamination under the skin. However, the small probe tip diameter and high velocity make the probe an inefficient syringe.

The electrical current through the probes may perform a very local cauterization function (assuming a full connection delivering electrical current). This cauterization function is possible from two different mechanisms. The delivery of the current tends to cause a very local heating, which could destroy bacteria and other pathogens by temperature increase. Due to the small amount of power delivered and the high heat dispersion from the small diameter probes, this modality – if active at all – may make an insignificant contribution.

The primary means of sterilization may be electroporation [78–80]. The local high current density – as brief as it is – can denature cells well before any significant temperature rise occurs. The electroporation occurs only in a very close region (<<1 mm) from the probe due to the high field gradient from the small diameter probe. Fortuitously, this may be apparently sufficient penetration to kill any pathogens on the probe surface. Frankly, the reasons for the absence of probe infections remain speculative.

Mortality

Traumatic Brain Injury from Falls

As discussed in the morbidity section, traumatic brain injury from a CEW-induced fall is not frequent but also not rare. It is difficult to sometimes separate the cause of a fall between the CEW, intoxication-induced imbalance, the physical resistance, and other LEO interactions. In the event, there have been about 12 cases of fatal falls, where the CEW probably played a role.

Case Study

Mr. Iman Morales's mother asked someone to call 911 after her emotionally disturbed son did not answer the door of his New York City apartment. When police arrived, Mr. Morales ran onto the fire escape outside his third-floor apartment.

Fleeing the officers up the fire escape, he tried to enter an apartment on the fourth floor by pushing in an air-conditioner. Unsuccessful, he then descended to the second-floor fire escape and from there jumped down to the security-gate housing for a ground-floor storefront, which was about 10 feet from the sidewalk.

As an officer was securing himself on the second-floor fire escape, Mr. Morales jabbed at him with an 8-foot-long fluorescent light tube.

Under orders from a lieutenant, the officer on the sidewalk used the TASER CEW on Mr. Morales, and he fell to the sidewalk, hitting his head. The police said an officer at the scene had radioed for an inflatable bag, and it was not clear why the bag had not arrived when Mr. Morales fell, or why the officers had not waited for it before using the TASER on Mr. Morales.

Mr. Morales was taken to a hospital with serious head trauma and was later pronounced dead [81].

Ignition

While a fall injury can occur from proper functioning of a CEW, an ignition-injury can only occur with suboptimum application. With good probe-to-body connections, there is likely no arcing and hence no opportunity for ignition of a volatile substance. However, if one probe fails to make a good connection, then the 50,000 V open-circuit "arcing" voltage will attempt to complete the connection. If the disconnected probe is more than 6 cm from the body, then an arc is unlikely at the body. In that situation, the arc will occur back at the muzzle of the officer's CEW, and there will likely be no ignition unless the volatile substance has sufficient concentration near the officer.

The volatile substances of most concern are: OC spray, petrol, and cooking gas. The OC (oleoresin capsicum or pepper) spray is only of concern if it is alcohol-based or contains other flammable substances or carriers. OC spray is available with non-flammable carriers and these are preferred within agencies that use electrical weapons. However, caution is necessary because some OC sprays – clearly labeled nonflammable – have been shown to be flammable during testing. Petrol – itself – is not ignitable with a spark. Evaporated petrol combined with air is highly ignitable and that is the key ingredient of the modern automobile engine. There is at least one case of a violent individual being ignited by a CEW after he had drenched himself with petrol.

Case Study

A man who doused himself with petrol then caught on fire after police fired a TASER CEW at him died from his injuries. Juan Flores Lopez, 47, was hospitalized and later died. Police said they used pepper spray while trying to take Lopez into custody, but that he was never handcuffed. Lopez had a can of petrol and a small lighter in his hand at one point. He tossed petrol at officers, but no one was injured. The Texas Rangers were investigating whether a lighter found at the scene could have contributed to the fire and whether the CEW played a role. Two of Lopez's sons who live nearby said their father had been threatening for months to burn himself and his house. His wife was seeking a divorce and he didn't want to have to leave the house, the sons said. Lopez also had a history of mental illness [82].

Electrocution

Background

No topic regarding the CEW has generated more controversy than the possibility of CEW-induced VF. This seems natural as the induction of VF is the manner by which strong electrical currents can directly cause death. Ironically, this issue has questionable relevance to CEW safety based on the epidemiological results.

Swerdlow et al. studied the cardiac rhythm in ARD cases in which a CEW had been used [83]. They found that the cardiac rhythms were predominantly bradyasystoles which is consistent with previous findings with drug overdoses or excited delerium [84, 85]. Swerdlow et al. found one case in which probe location and VF temporality were consistent with CEW-induced VF. (There are other facts that may exculpate the CEW in this case.) Assuming arguendo that there were a handful of CEW-induced VF cases, out of over 1.3 million field applications, this mortality risk would appear to be extremely low for a weapon. A prolific CEW VF animal researcher, John Webster, has concluded: [86]

> "It's a few-per-million kind of thing," Webster said in the National Review of Medicine of the chances a stun gun prod could produce death. "You've got to have a very thin person with a dart between his ribs right over his heart."

In spite of the possible lack of relevance, or epidemiological importance surrounding the VF risk, it will be discussed in detail here due to the emotional controversy.

"Electrocution" is the term first coined in the late 1800s to describe the government's execution of a criminal by use of electricity. It was a contraction of "electrical execution." Today, the term "electrocution" is more broadly used to describe the induction of a cardiac arrest by the application of, or exposure to, electrical shock. This is what has been theorized as the mechanism by which a CEW could allegedly kill a person. It is an immediate death – on the order of seconds (≤5 s) – as electricity does not linger or build up in the body like a poison [87–95].

The electrical induction of VF has recently become one of the best scientifically researched causes of death. Paradoxically, this is due to the surgical implantation of lifesaving ICDs about 500 times per day when a cardiac EP will intentionally electrocute (use electricity to induce a cardiac arrest) a patient [96, 97]. The ICD will then recognize the ensuing electrically induced VF and deliver a lifesaving electrical shock thus verifying the ICD's proper function.

From this experience of over 1,000,000 such intentional electrocutions, certain facts have been medically and scientifically established beyond any shadow of a doubt:

1. VF is either induced or not induced within 1–5 s [89, 90, 93, 95, 98]. (The VF mechanism of long-term hypotensive cardiac capture is discussed later.)
2. Cardiac rhythms of asystole and PEA (pulseless electrical activity) are not induced by the electrical pulses.
3. The cardiac pulse disappears immediately [99].
4. The patient loses consciousness within 5–15 s.
5. A sufficiently strong defibrillation shock – either internal or external – restores a cardiac sinus rhythm 99.9% of the time [98].
6. There is no increased risk of a later VF since electrical current does not linger, or build up, in the body as a poison or drug might.

As discussed under "Selective Nerve Stimulation," the CEW pulse durations are optimized to stimulate motor neurons and not cardiac cells (See Table 8.5 for summary of issues).

Table 8.5 Factors promoting cardiac safety in spite of skeletal muscle control

Short durations of the electrical pulse which stimulate skeletal muscles better than cardiac tissue
The anatomic location of the heart is farther from the barbs than the skeletal muscles
Anisotropy (tendency of current to follow muscle grain) of skeletal muscle tending to conduct (shunt) current around the thorax instead of into the thoracic cavity
Electrical shielding effect of the perpendicular muscle grain between the pectoralis major and minor, between pectoralis minor and intercostals, and between the intercostals and the epicardium
The electrical shielding effects of the lungs around large portions of the heart

The second reason why the motor neurons are excited by the CEW pulse – while the heart muscle is not – is that the motor neurons are much closer to the electrodes than is the heart. This also explains why the muscles most affected are those nearest to the electrodes of the CEW. The different electrical resistivities of the various body tissues, the shunting effects of the thoracic cage, the anisotropic shielding of various tissues, and the relative insulating effect of the air-filled lungs also cause the electric field to be many times smaller in the heart than in the surface tissues near the electrodes. Most of the current flows around the chest between the two electrodes in the skeletal muscles. Electrical current prefers to flow with the grain of a muscle vs. flowing against the grain by a factor of about 10:1 [100]. In fact, the amount of electrical current that passes through the heart from electrical pulses delivered to the chest wall is only about 4–10% of the total current delivered through chest electrodes [101, 102].

Also, the 4–10% value occurs when electrodes are optimally placed to intentionally attempt to affect the heart, such as with external pacing or defibrillation. When the electrodes are elsewhere on the body, as they are in the large majority of cases when the CEW is used, the percentage of applied electrical current that traverses the heart is far less. Also, drive-stun applications deliver minimal current below the surface of the body.

MRI (Magnetic Resonance Imaging) studies show that electrical current has an additional impediment passing between the intercostal muscles and the cardiac muscles, as their fibers are perpendicular to one another [100]. Careful computer modeling studies show that very little CEW current goes more than 1 cm below the skin [103–105].

Common Myths

The Poison Intuition

VF can be induced by sufficiently strong electrical current flowing through the body. The current that is required to directly induce VF is dependent on the length of time, but only up to a few seconds. It is well established that the direct VF induction threshold decreases for the first few seconds and does not decrease further [87, 89–92, 106]. In other words, if a person is not put directly into VF by a certain level of electrical current after 5 s, the person will not be electrocuted by a 60+ second exposure either [107]. (There are second-order effects from long term – i.e., minutes long applications of electrical currents. This is probably not applicable to electrical weapons, but will be discussed later for completion).

Both the IEC and UL regulations recognize that electrocution either happens in the first few seconds or does not happen [108]. Electrical currents that will not directly induce VF in 5 s will not induce VF in 1 min [107].

Animal studies going back to the 1930s show that the risk of inducing VF does not build up (increase) after the first few seconds. The “critical time” is the time at which further applications of electrical current do not increase the risk of directly inducing VF. These studies have found that the critical time ranges from 0.8 to 5 s [87, 89–92, 106]. Based on the animal results above, Biegelmeier and Lee calculated that the critical time ranged from 2 to 5 s for humans due to the lower heart rate [89, 90]. More recently, Swerdlow et al. demonstrated that the human VFT dropped dramatically when going from 0.5 to 1.0-s long applications [94]. The VFT fell by another 54% going from 1 to 5-s applications consistent with the Biegelmeier predictions.

Russian Roulette

The suggestion that the CEW could induce VF by shocking into the vulnerable period of the heartbeat cycle has been referred to as “Russian Roulette,” “Lightning Lottery,” or the “Tailspin” [109–111].

As discussed previously, the “vulnerable” period of the cardiac rhythm is also the point where a blunt trauma mechanical shock could cause VF by *commotio cordis*. The most vulnerable section of the cardiac rhythm is the first half of the T-wave and this lasts about 54 ms on average in humans [112]. The X26 CEW puts out 19 pps. That means that the spacing between pulses is 1/19th of a second or 52.6 ms. In other words, for the average individual, no vulnerable period escapes the X26 CEW pulsing – the X26 CEW pulse hits every T-wave.

Animal Studies

Probe-mode chest X26 CEW applications to small swine can occasionally induce VF. This appears to be limited to swine around 30 kg or smaller.

It has been known for over 70 years that swine are unusually sensitive to the electrical induction of VF [106]. We also know some of the reasons why. In canines and humans, the Purkinje fibers are confined to a very thin endocardial layer [113]. In swine, the Purkinje fibers cross the entire ventricular wall [114]. It has been recently demonstrated that activation in swine proceeds from the epicardium to the endocardium, while in canines and human that activation proceeds in the reverse direction [115]. Thus, swine are much more sensitive to external electrical currents. Swine hearts are literally wired inside out compared to humans.

In addition, swine are extremely sensitive to higher frequency currents. Ventricular ablation with radio frequencies is routinely done in human beings without problems, yet will typically result in VF in swine [116]. A possible cause (beyond the transmural Purkinje fibers) for this difference lies with significant ion channel differences [117]. Finally, swine have a short repolarization reserve [118, 119].

The electrical current threshold for VF is approximately proportional to the body weight for both utility power and CEW pulses [120–122]. This has raised the issue of the scalability of these results to heavier humans as the mean weight of excited delirium deaths is 91 kg [123].

In 8 published peer-reviewed papers studying the application of X26 CEW chest exposures to swine, the heart was in the current path between the barbs [33, 61, 122, 124–128]. Swine weights were scaled using a moderate correction (human weight = 0.72* swine weight) from the classic Dalziel data [120] even though more recent evidence suggests that swine are even more sensitive to the induction of VF [115–117]. The cases of reported VF induction in swine were then entered (along with the exposures not inducing VF) into a logistic regression model. Acute epinephrine effects were scaled using the published 28% VFT reduction [32].

The swine studies covered 117 chest exposures in 81 swine weighing between 22 and 117 kg. There were 3 inductions of VF in 56 tests with swine of ≤ 37 kg for a probability of 0.05. There were no VF inductions in swine of >37 kg. These data were well fit ($r^2 = 0.81$ by U test) to a logistic regression model ($p = 0.0003$ by Wald chi-square test) as shown in Fig. 8.9. The human weight at which VF induction is likely ($p > 0.5$) is predicted to be 13.3 kg (confidence limits: 7.1, 21.2 kg). These estimates are conservative as the majority of CEW chest exposures do not include the heart in the current path. The predicted probability of VF in a 91-kg human is 3.4×10^{-12} (confidence limits: 4.5×10^{-23}, 3.2×10^{-7}).

Human Studies

The presenting cardiac rhythm with ARDs is usually either bradyasystole or PEA – rhythms that are typically associated with excited delirium or drug overdose deaths [129–133]. A natural concern is whether or not there may have been electrically induced cases of VF which deteriorated to asystole. This appears to be unlikely for several reasons. First, in the majority of the cases reported by Swerdlow et al., the cardiac rhythm was documented within 5 min. Secondly, in many of the other cases, the EMS was present about the time of the LEOs arrival and were staged waiting for the officers to gain control of the subject. In many of these cases, LEOs applied their own AED (automatic external defibrillator) which reported “No shock advised,” thus eliminating VF as the presenting cardiac rhythm. Finally, the time course of VF deteriorating to asystole – from electrically induced VF – is far longer than generally appreciated. Studies of canines, swine, and sheep have found no deterioration to asystole from electrically induced VF out to the limits of their monitoring time of 10–20 min [115, 134, 135].

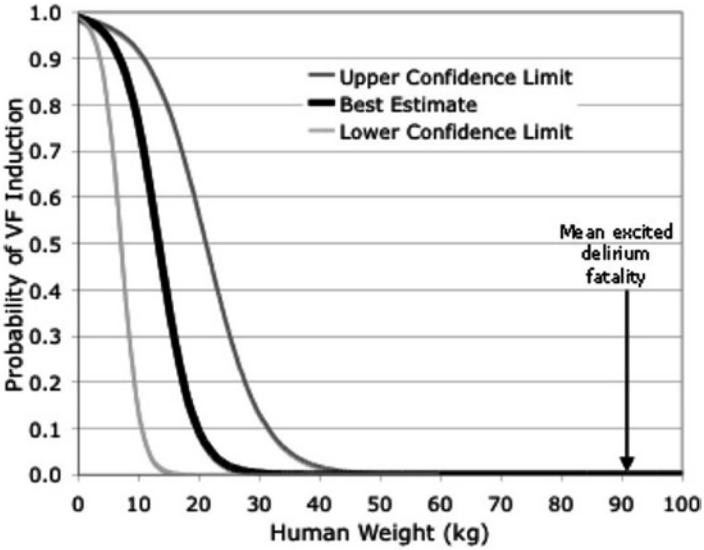

Fig. 8.9 Probability of direct CEW VF induction by a chest application of an X26 CEW as a function of human body weight. Calculated from meta-analysis of swine studies

In the one clearly documented human case, of the deterioration of electrically induced VF into asystole, the time required was 42 min [136]. For spontaneous VF – without CPR, the median time to asystole is 19 min [137]. Human beings have been kept in VF for over an hour with cardiac massage without deteriorating into asystole [138]. LEOs are trained to administer chest compression in the event of a collapse. This will further extend the time for deterioration of VF into asystole.

Numerous computer modeling studies have been done to evaluate the electrical current reaching the heart and the risk of the direct induction of VF by a CEW. The most exhaustive study was done by Holden et al. which suggested a 240:1 safety margin for the direct induction of VF [139]. Panescu et al. similarly found that electrical current density at the heart was significantly below that required to directly induce VF. The Webster group recently reported that the risk of direct induction of VF from a CEW application was 6 PPM (parts per million). However, that modeling database was dominated by thin females and thus the 6 PPM stated risk significantly exaggerates the risk in males. Webster's data relied upon skin to heart echocardiograms of 150 subjects. Of those 150 subjects, Webster stated that 8 of the 150 had a sufficiently narrow skin to heart distance for the induction of VF. Webster's paper fails to mention that of the 8 subjects, 7 were females. Thus, the probability of CEW directly induced VF in males is far less than Webster's stated 6 PPM. It has been suggested that the group uses their model to predict the VF risk in males and hopefully that will be done in the near future. The risk in males is 0.4 PPM.

Ideker et al. used transthoracic pacing data to predict the VF safety margin and estimated that the safety margin was 28:1 [140]. Multiple human studies using anterior chest applications have uniformly reported zero incidents of VF [67, 68, 141–143]. These studies included contra-lateral electrode placements to test primarily for respiration impairment. In addition, other studies have used continuous echocardiographic monitoring and have not found VF [144–147]. Bozeman et al. combined published US data with UK Home Office data covering 4,058 consecutively monitored CEW field uses in which the electrical current was actually delivered [148]. There were no cases of cardiac death related to the CEW usage.

Minimum requirements for the assessment of CEW electrocution are given in Table 8.6.

Case Study

There has yet to be a case in which all authorities agree that a CEW induced VF in a human. The case presented here is the first (and possibly only) one in which the medical examiner ruled a death due to "electrocution" by a CEW.

> Chicago police officers and paramedics were called to a high-rise apartment building where Mr. Ronald Hasse was naked and talking to aliens on his cellular telephone. Police officers used a TASER X26 CEW to attempt to get Mr. Hasse under control. After application of the CEW Mr. Hasse was handcuffed and helped to climb into the paramedics stair-chair. Paramedics then verified Mr. Hasse's pulse and respiration. Police and paramedics agree that Mr. Hasse was alert and breathing — with eyes open — as he was wheeled into the elevator.
>
> At the ground level of the high-rise — 8 minutes after the CEW applications — Mr. Hasse was unresponsive, found to be in VF and aggressive resuscitation therapy was given unsuccessfully. Mr. Hasse was pronounced deceased in the hospital about 60 minutes later. Toxicology later showed a blood methamphetamine level of 0.55 μg/ml.
>
> The local deputy medical examiner (DME) blamed the TASER CEW as the primary cause of Mr. Hasse's death in his autopsy report stating that the Mr. Hasse's death was by "*electrocution*" from the CEW (with the contribution of methamphetamine) [149]. Material concerns regarding this autopsy conclusion include: (1) blaming the CEW when the subject had normal pulse and respiration after the application as the electrical induction of VF causes loss of both within seconds, (2) relying on an unsupported speculation of a dysynergy between electrical current and methamphetamine, (3) ignoring the 8-minute gap between the CEW application and the collapse, (4) ignoring the subject's alertness minutes after the CEW application, and (5) ignoring the failure of defibrillation shocks.
>
> An additional concern was raised years later when the DME, admitted under oath, that his supervisor had suggested the term "electrocution." There were speculations of conflict with the supervisor [150].

Cardiac Capture Issue

Another topic that must be considered for completion is that of long-term high-rate cardiac capture. This has been hypothesized as a possible mechanism for the induction of VF in a field situation. This is an issue worthy of examination as high-rate cardiac capture will occur at electrical current levels about 1/3 of those required to directly induce VF. High-rate cardiac capture is commonly seen in small swine when the CEW probes are placed deeply and close enough to the heart [33, 126, 151].

Table 8.6 Electrocution checklist

Present?	Not present	Criterion	Rationale
From law enforcement reports			
		Probe-mode deployment (instead of drive-stun)	Drive-stun mode is not able to directly induce VF even in small swine [126, 159]
		Use of X26 CEW instead of M26 CEW	The M26 is unable to directly induce VF even in smaller swine (and canines), while this has occurred in swine with the X26 [33, 34]
		Subject collapse within 15 s (s) of *initiation* of a probe-mode application	The direct electrical induction of VF requires 2–5 s [89, 90, 93, 95, 98, 107] Subject collapse in VF occurs within 10 s of the VF initiation [99]
From EMS report			
		A defibrillator shock applied to the person within 8–10 min of VF terminates the VF. Law enforcement defibrillator may have been used	Electrically induced VF is terminated by a defibrillation shock 99.9% of the time (if delivered promptly) [98, 160]. After 12 min (with cardiopulmonary resuscitation [CPR]), this falls to 88% [160]
		Cardiac rhythm seen within 30 min of the collapse is VF. This is demonstrated either by an external defibrillator announcing "shock advised" or by a paramedic's EKG recording	Most cardiac rhythms seen with acute or chronic drug effects or excited delirium are not VF [83, 85, 123, 161, 162] After 30 min of a possible VF, the rhythm may deteriorate to another type of arrhythmia [115, 136]

(continued)

Table 8.6 (continued)

Present?	Not present	Criterion	Rationale
		Initial presenting rhythm is not asystole or PEA	Asystole and PEA cannot be induced with electrical stimulation. This criterion is not valid after 30 min from collapse as VF will eventually deteriorate into asystole or PEA [136]. Unsuccessful defibrillation shocks can convert VF into asystole or PEA, but that is different
From autopsy			
		One probe was directly over a cardiac ventricle (main chambers of the heart)	When VF has been induced in the small swine, at least one of the probes was over a ventricle [126, 163]
		The probe directly over the cardiac ventricle penetrated the skin and did not simply penetrate or lodge in the person's clothing	VF has only been induced even in swine with a fully inserted probe [33, 127, 128, 163]
		Penetration of the probe through the intercostals in the left parasternal region	
		The penetrating probe over the heart penetrated straight in and was not at an angle that would negatively affect the dart-to-heart distance	Webster group predicted, from porcine studies, that VF induction would require a very thin person with a full 9 mm barb penetration [163]
		The dart tip-to-heart distance is a maximum of 6 mm. For exposures of >90 s, this critical distance is probably 15 mm [155] (15–20 mm in swine) [153, 154]	The most extreme distance found by the Webster group for VF induction – in swine – was 8 mm with an average of 6 mm, and a minimum of 2 mm [163]. Swine are easy to fibrillate and thus present a conservative model [116, 120, 164]

Items 3, 9, and 10 do not apply completely to situations of exposures >90 s

For background, it should be noted that there is nothing intrinsically dangerous about long-term cardiac capture. Cardiac capture, after all, is how pacemakers keep pacemaker patients alive. However, if the electrical current delivered to the heart was strong enough to cause high-rate capture (220–280 BPM), there would be a significant loss of cardiac output. This could eventually lead to VF when the ischemic acidosis sufficiently lowered the VFT. The median time for this to occur has been variously reported as 1.5–4 min (90–240 s) [152–154]. A canine study found that it could not occur in 60 s, but the study durations did not extend beyond 60 s [107]. There have been two reports of a single swine each in which this (high-rate cardiac capture deteriorating into VF) occurred with a CEW exposure of 80 s [124, 153].

Long before the high-rate cardiac capture could induce VF, the subject would be syncopal from the lack of cardiac output. This would cause the subject to stop fighting and resisting within 5–10 s of the CEW application. This simple physiological fact appears to have been overlooked when the hypothesis of lethal long-term capture has been raised. To put a blunter point on this issue, the following scenario would be required before long-term cardiac capture would be considered to be contributing to a death:

1. A violent subject receives a CEW probe discharge over the heart.
2. The subject is thin and a relatively precise probe placement and penetration depth obtains allowing high-rate cardiac capture.
3. The high-rate cardiac capture causes syncope within about 10 s.
4. The subject collapses to the ground and stops resisting.
5. The LEO unnecessarily holds the trigger back for approximately 2 min in spite of the fact that the subject stopped resisting at 5–10 s.
6. The subject experiences VF.

The electrical current ratio between high-rate cardiac capture and VF is about 1:3. Lakkireddy et al. found the ratio to be about 1:3 in swine with X26 CEW pulses, and Swerdlow et al. found it to be 1:3 in humans with 60 Hz utility power [29, 94].

Published echocardiographic studies with chest application studies in humans (with either probes or EKG electrodes) have not reported cardiac capture with available devices [144, 146, 147]. However, there was a case – in a study of a research CEW (not sold) – a pectus excavatum subject (68 kg) that had high-rate cardiac capture from a probe inserted directly towards his right ventricle in a left parasternal intercostal space [155]. The probe tip was 15 mm from the epicardium. Cardiac capture was echocardiographically documented at ~240 BPM and the supine subject reported no syncope at the time the predetermined 10-s CEW exposure was completed. No VF was induced.

Death Investigation

There is much overlap between the typical ARD investigation and one in which a CEW was involved. However, there are also numerous differences. The author worked with other experts advising the Los Angeles County Sherriff's Department, California, USA, to generate the investigative list given in Table 8.7.

Table 8.7 Death investigation checklist

Arrest-related death evidence collection
Highly perishable evidence (some items repeated below)
Get the AED (automatic external defibrillator) or cardiac monitor downloads (including strips and technical operational downloads). This is usually erased when the next paramedic shift starts. This information can eliminate "electrocution" by the CEW (conducted electrical weapon) 95% of the time. However, it is erased 80% of the time. Note that there can be 4 defibrillators: (1) squad car, (2) paramedics, (3) ambulance, and (4) hospital
Maintain as evidence the CEW wires and probes. Microscopic analysis of the probes and wires will often show that no electrical current was delivered (as one probe missed) or no circuit was completed or electrical charge delivered to the person and eliminate the CEW as a factor
Core (rectal or liver) body temperatures at as close to time of collapse as possible by medical personnel. Not considered important by EMS (emergency medical services) or ED (emergency department) staff for therapy, but important for excited delirium diagnosis
Paramedic pulse oximeter recording if available
End tidal CO_2 measurement from paramedics during CPR or after they intubated the subject. Often not recorded
Premortem blood sample from ED in proper preservative tube for "quantitative" analysis – not just "qualitative" analysis
If postmortem blood sample – get several blood samples (especially peripheral samples) and place in proper preservative tube for quantitative analysis – to avoid continuing metabolism within the tube
Important requests for ME (medical examiner)
Hair sample and chronic drug use analysis. At least save a head hair sample (pencil thick when twisted) and a pubic hair sample
Mash Miami brain test. (+1-800-UM-BRAIN and http://www.exciteddelirium.org)
Save the heart (histologic heart blocks may be very important)
If any TASER probes were within 5 cm of the heart, ME should measure the exact distance in mm (millimeters) from the tip of the probe to the outer surface of the heart
Collect and analyze gastric contents
Acute medical information
Body core (rectal or liver) temperature at time of death and as close to collapse as possible
Collect 10 mL (milliliters) of blood as soon as possible after ED arrival for later quantitative drug testing
Within 24 (preferably less than 12) hours of collapse, brain samples must be properly collected and frozen. Call 1 800 UM BRAIN (also http://www.exciteddelirium.org) for shipping instructions
In suspected cocaine, methamphetamine, PCP, etc. smoking cases, swabs of mouth and bronchial tree are helpful for chemical analysis
Chronic medical information
Obtain in hair and toe-nail samples. Twist strands of longest head hair available like a lock, about as thick as a pencil lead, hold together to keep strands aligned as you cut as close to skin as possible. Transfer lock to tin foil or paper, fold (to hold together), and secure. Collect similar samples from longest pubic/groin hair
Obtain all available past medical records
Obtain printouts from pharmacies used by suspect for past 2 years
Obtain all criminal justice records
Obtain all rehabilitation and treatment records

(continued)

Table 8.7 (continued)

Arrest-related death evidence collection
Circumstances regarding arrest
Distance CEW fired, probe spread, location, and duration of cycles
CEW effects (any change in behavior?)
Subject's influence (drugs, alcohol, EDP)
Any other use of force employed?
Was an AED, defibrillator, or cardiac monitor used?
Did the AED report a shockable rhythm?
Is there a printout (download) from the AED or cardiac monitor?
How long between the CEW exposure and the subject's collapse? Specifically detailed chronicle of all witnessed behaviors, actions, inactions, physiological status, etc.
Was the subject walking, fighting, or talking after the exposure?
ME's contact info or supporting info from medical attendants and ED
Hospital exam information (if conducted)
Interviews
Treat the EMTs (emergency medical technicians) and Paramedics etc. at the scene like any other witnesses. Get complete statements from them about what they observed and what interventions they made. Very often, they can make medical observations that the LEOs might not realize are important but they will have forgotten by the time their depositions are taken 2–3 years later
Try to get eyewitness statements that address the rapidity with which the subject went from screaming, struggling, and yelling to unconscious, not breathing, and pulseless. Remember that a respiratory death takes minutes, whereas a cardiac death takes only a few seconds. Try to specifically determine the time sequence as clearly and carefully as possible in the early phase of the investigation. Advise LEOs to collect as much information about the passage from activity to unconsciousness as possible. The sequence of events for a sudden cardiac death as opposed to a respiratory death is markedly different and chronicaling exactly what happened, how fast, when, and whether there was resistance, exertion, struggling, or fighting until "all of a sudden" or like a "light switch" things changed can be most important information
Get statements that include whether or not the subject could be heard to be breathing, screaming, yelling, etc. throughout their confrontation against LEOs efforts to capture, control, and restrain. Screaming and yelling require that air is moving over the vocal cords and demonstrate that at least some degree of ventilation had to take place. How much yelling and screaming?
Debrief LEOs and witnesses regarding words and actions manifested by subject. Get details of patterns of walking, talking, gestures, facial expressions, breathing, pulse, etc. Ask interviewees to replay their memory with attention to DUI (driving under the influence)/DRE (drug recognition expert) type details. Sounds, even grunts, growls, and snarls are important. Get collaborative reports
Was suspect growling? How?
What words could you make out?
Huffing and puffing?
Sweating?
Drooling?
Eye movements?
Balance?
If subject is only injured and survives, debrief as soon as possible about subjective feelings, thoughts, and drug effects. They were the only ones inside their bodies and looking out so ask how they saw and heard the world. Don't translate anything into your own words, but describe mannerisms and expressions accompanying their descriptions

(continued)

Table 8.7 (continued)

Arrest-related death evidence collection
Evidence collection
Photos of wounds and CEW probe or drive-stun impacts with scale
Photos showing distance of probe or drive-stun spread (scale)
Keep the original CEW battery in the CEW (DO NOT remove). This will keep the integrity of the internal clock
Do not discard probes or wires (treat them as evidence). Do not let EMS place probes in "sharps" container as information can be gathered from the probes and wires as to whether or not they actually delivered current
Download CEW data within 48 h of the event and maintain evidentiary copy of download (including time drift)
Collect minimum of 2–3 AFID (antifelon identification) tags and note their location; this will be helpful if multiple CEWs or cartridges were deployed
Medical/autopsy data and tissues
All treatment records
EMS
Emergency department
Autopsy report
Autopsy microscopic slides (if any were prepared)
Autopsy gross tissues (if any were retained)
Heart is especially useful
If the CEW did not perform as expected
What was the failure or challenge?
What was the subject wearing (especially, multiple layers, thick layers, loose clothing, etc.)
Collect clothing, closely photograph puncture, or lack of puncture marks
Was the CEW dropped or subject to a high-moisture environment?
What were the operating conditions?
Did the CEW fire?
Did LEOs hear loud arcing – especially across the front of the CEW?
Drive-stun or probe deployment?
When was a last successful download or spark test done?

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References

1. Dawes DM, Ho JD, Kroll MW, Miner JR (2010) Electrical characteristics of an electronic control device under a physiologic load: a brief report. Pacing Clin Electrophysiol 33(3): 330–336
2. Reilly J, Diamant A, Comeaux J (2009) Dosimetry considerations for electrical stun devices. Phys Med Biol 54:1319–1335

3. Lapicque L (1909) Definition experimentale de l'excitabilite. CR Acad Sci 67(2):280–283
4. Weiss G (1901) Sur la possibilite' de rendre comparable entre eux les appareils survant a l'excitation electrique. Arch Ital de Biol 35:413–446
5. Reilly JP (1992) Cardiac sensitivity to electrical stimulation. Electrical stimulation and electropathology. Cambrige University Press, NY, pp 180–230
6. Reilly JP (1998) Applied bioelectricity: from electrical stimulation to electrical pathology. Springer, New York
7. International Electrotechnical Commission (2006) Household and similar electrical appliances – safety – part 2 – 76: particular requirements for electric fence energizers. In: Commission IE (ed) IEC 60335-2-76, edn 2.1. Vol IEC 60335-2-76, edn 2.1. 2.1 ed. IEC, Geneva
8. Underwriters Laboratories (2003) UL standard for electric-fence controllers. In: Laboratories U (ed) UL 69. Vol UL 69. 9 ed. Underwriters Laboratories, Northbrook
9. Nimunkar AJ, Webster JG (2009) Safety of pulsed electric devices. Physiol Meas 30(1):101–114
10. International Electrotechnical Commission (2007) Effects of current on human beings and livestock – part 2: special aspects. IEC 60479–2. 3rd Ed
11. Kouwenhoven WB, Hooker DR, Lotz EL (1936) Electric shock effects of frequency. AIEE Trans 55:384–386
12. Roberts J (2008) Medical effects of TASERs. Emerg Med News 30(2):12–15
13. Blain M (2008) Taser threat helps deter most suspects, national figures show. Janes police review. Janes, London
14. International Electrotechnical Commission (1988) Medical electrical equipment, part 1: general requirement for safety. International Electrotechnical Commission, Geneva
15. Cao M, Shinbane JS, Gillberg JM, Saxon LA, Swerdlow CD (2007) Taser-induced rapid ventricular myocardial capture demonstrated by pacemaker intracardiac electrograms. J Cardiovasc Electrophysiol 18(8):876–879
16. Haegeli LM, Sterns LD, Adam DC, Leather RA (2006) Effect of a Taser shot to the chest of a patient with an implantable defibrillator. Heart Rhythm 3(3):339–341
17. Vanga SR, Bommana S, Kroll MW, Swerdlow C, Lakkireddy D (2009) TASER conducted electrical weapons and implanted pacemakers and defibrillators. Conf Proc IEEE Eng Med Biol Soc 1:3199–3204
18. Nelson R, Gilman B, Shapland J, Lehmann M (1996) Leads for the ICD. In: Kroll M, Lehmann M (eds) Implantable cardioverter-defibrillator therapy: the engineering-clinical interface. Kluwer Academic Publishers, Norwell, pp 173–204
19. Panescu D, Stratbucker R (2009) Current flow in the human body. In: Kroll M, Ho J (eds) TASER® electronic control devices: physiology, pathology, and law. Springer, New York
20. Eastman AL, Metzger JC, Pepe PE et al (2008) Conductive electrical devices: a prospective, population-based study of the medical safety of law enforcement use. J Trauma 64(6):1567–1572
21. Koplan BA, Gilligan DM, Nguyen LS, Lau TK, Thackeray LM, Berg KC (2008) A randomized trial of the effect of automated ventricular capture on device longevity and threshold measurement in pacemaker patients. Pacing Clin Electrophysiol 31(11):1467–1474
22. Brewer J, Kroll M (2009) Field statistics overview. In: Kroll M, Ho J (eds) TASER® electronic control devices: physiology, pathology, and law. Springer, New York
23. Pozner CN, Levine M, Zane R (2005) The cardiovascular effects of cocaine. J Emerg Med 29(2):173–178
24. Qureshi AI, Suri MF, Guterman LR, Hopkins LN (2001) Cocaine use and the likelihood of nonfatal myocardial infarction and stroke: data from the Third National Health and Nutrition Examination Survey. Circulation 103(4):502–506
25. Karch SB (1996) Cardiac arrest in cocaine users. Am J Emerg Med 14(1):79–81
26. Schwartz AB, Boyle W, Janzen D, Jones RT (1988) Acute effects of cocaine on catecholamines and cardiac electrophysiology in the conscious dog. Can J Cardiol 4(4):188–192
27. Schwartz AB, Janzen D, Jones RT (1989) Electrophysiologic effects of cocaine on the canine ventricle. J Cardiovasc Pharmacol 13(2):253–257
28. Tisdale JE, Shimoyama H, Sabbah HN, Webb CR (1996) The effect of cocaine on ventricular fibrillation threshold in the normal canine heart. Pharmacotherapy 16(3):429–437

29. Lakkireddy D, Wallick D, Ryschon K et al (2006) Effects of cocaine intoxication on the threshold for stun gun induction of ventricular fibrillation. J Am Coll Cardiol 48(4):805–811
30. Inoue H, Saihara S, Toda I, Sugimoto T (1989) Summation and inhibition by ultrarapid train pulses in dogs: effects of frequency and duration of trains, lidocaine, and beta blockade. Pacing Clin Electrophysiol 12(11):1777–1786
31. Mitrani RD, Miles WM, Klein LS, Zipes DP (1998) Phenylephrine increases T wave shock energy required to induce ventricular fibrillation. J Cardiovasc Electrophysiol 9(1):34–40
32. Han J, Garciadejalon P, Moe GK (1964) Adrenergic effects on ventricular vulnerability. Circ Res 14:516–524
33. Nanthakumar K, Billingsley IM, Masse S et al (2006) Cardiac electrophysiological consequences of neuromuscular incapacitating device discharges. J Am Coll Cardiol 48(4):798–804
34. McDaniel W, Stratbucker R, Smith R (2000) Surface application of TASER stun guns does not cause ventricular fibrillation in canines. Proc Annu Int Conf IEEE Eng Med Biol Soc. 2000.
35. Wilkinson D (2005) PDSB Further evaluation of TASER devices. Publication No. 19/2005. http://www.homeoffice.gov.uk/docs3/psdb09-02.pdf
36. Ho J, Dawes D, Cole J et al (2010) Effect of an electronic control device exposure on a methamphetamine intoxicated animal model. Acad Emerg Med 17(4):436–443
37. Home_Office (2009) Figures on the reported and recorded uses of Taser by police forces in England and Wales. Scientific Development Branch, Sandridge
38. MacDonald JM, Kaminski RJ, Smith MR (2009) The effect of less-lethal weapons on injuries in police use-of-force events. Am J Public Health 99(12):2268–2274
39. Lee BK, Vittinghoff E, Whiteman D, Park M, Lau LL, Tseng ZH (2009) Relation of Taser (electrical stun gun) deployment to increase in in-custody sudden deaths. Am J Cardiol 103(6):877–880
40. Bozeman WP, Hauda WE 2nd, Heck JJ, Graham DD Jr, Martin BP, Winslow JE (2009) Safety and injury profile of conducted electrical weapons used by law enforcement officers against criminal suspects. Ann Emerg Med 53(4):480–489
41. Chen SL, Richard CK, Murthy RC, Lauer AK (2006) Perforating ocular injury by Taser. Clin Exp Ophthalmol 34(4):378–380
42. Han JS, Chopra A, Carr D (2009) Ophthalmic injuries from a TASER. CJEM 11(1):90–93
43. Ng W, Chehade M (2005) Taser penetrating ocular injury. Am J Ophthalmol 139(4):713–715
44. Seth RK, Abedi G, Daccache AJ, Tsai JC (2007) Cataract secondary to electrical shock from a Taser gun. J Cataract Refract Surg 33(9):1664–1665
45. Mangus BE, Shen LY, Helmer SD, Maher J, Smith RS (2008) Taser and Taser associated injuries: a case series. Am Surg 74(9):862–865
46. Rehman TU, Yonas H, Marinaro J (2007) Intracranial penetration of a TASER dart. Am J Emerg Med 25(6):e733–e734
47. Bui ET, Sourkes M, Wennberg R (2009) Generalized tonic-clonic seizure after a taser shot to the head. CMAJ 180(6):625–626
48. Hinchey PR, Subramaniam G (2009) Pneumothorax as a complication after TASER activation. Prehosp Emerg Care 13(4):532–535
49. Sloane CM, Chan TC, Vilke GM (2008) Thoracic spine compression fracture after TASER activation. J Emerg Med 34(3):283–285
50. Winslow JE, Bozeman WP, Fortner MC, Alson RL (2007) Thoracic compression fractures as a result of shock from a conducted energy weapon: a case report. Ann Emerg Med 50(5):584–586
51. Taser-hit man burst into flames. BBC World News. 21 July 2009
52. Karch S (2009) Stimulant abuse and sudden cardiac death. In: Kroll M, Ho J (eds) TASER® electronic control devices: physiology, pathology, and law. Springer, New York, pp 315–325
53. Karch SB, Green GS, Young S (1995) Myocardial hypertrophy and coronary artery disease in male cocaine users. J Forensic Sci 40(4):591–595
54. Awtry EH, Philippides GJ (2010) Alcoholic and cocaine-associated cardiomyopathies. Prog Cardiovasc Dis 52(4):289–299

55. Jauchem JR, Cook MC, Beason CW (2008) Blood factors of Sus scrofa following a series of three TASER electronic control device exposures. Forensic Sci Int 175(2–3):166–170
56. Ho J, Dawes D (2009) TASER device induced rhabdomyolysis is unlikely. J Emerg Med. Jan 2011;40(1):68–69
57. Ho JD, Miner JR, Lakireddy DR, Bultman LL, Heegaard WG (2006) Cardiovascular and physiologic effects of conducted electrical weapon discharge in resting adults. Acad Emerg Med 13(6):589–595
58. Dawes DM, Ho JD, Sweeney JD, Lundin EJ, Kunz SN, Miner JR (2011) The effect of an electronic control device on muscle injury as determined by creatine kinase enzyme. Forensic Sci Med Pathol 7(1):3–8
59. Vanmeenen KM, Cherniack NS, Bergen MT, Gleason LA, Teichman R, Servatius RJ (2010) Cardiovascular evaluation of electronic control device exposure in law enforcement trainees: a multisite study. J Occup Environ Med 52(2):197–201
60. Jauchem JR (2009) Repeated or long-duration TASER((R)) electronic control device exposures: acidemia and lack of respiration. Forensic Sci Med Pathol 6(1):46–53
61. Jauchem JR, Sherry CJ, Fines DA, Cook MC (2006) Acidosis, lactate, electrolytes, muscle enzymes, and other factors in the blood of Sus scrofa following repeated TASER exposures. Forensic Sci Int 161(1):20–30
62. Ho J, Dawes D (2008) The effect of the eXtended Range Electronic Projectile (XREP) on breathing. Australian College of Emergency Medicine Winter Symposium. Newcastle
63. Dawes D (2009) Effects of CEWs on respiration. In: Kroll M, Ho J (eds) TASER conducted electrical weapons: physiology, pathology, and law. Springer-Kluwer, New York City
64. Ho J, Lapine A, Joing S, Reardon R, Dawes D (2008) Confirmation of respiration during trapezial conducted electrical weapon application. Acad Emerg Med 15(4):398
65. Vilke GM, Sloane CM, Bouton KD et al (2007) Physiological effects of a conducted electrical weapon on human subjects. Ann Emerg Med 50(5):569–575
66. Ho JD, Dawes DM, Bultman LL et al (2007) Respiratory effect of prolonged electrical weapon application on human volunteers. Acad Emerg Med 14:197–201
67. Ho JD, Dawes DM, Cole JB, Hottinger JC, Overton KG, Miner JR (2009) Lactate and pH evaluation in exhausted humans with prolonged TASER X26 exposure or continued exertion. Forensic Sci Int 190(1–3):80–86
68. Ho JD, Dawes DM, Bultman LL, Moscati RM, Janchar TA, Miner JR (2009) Prolonged TASER use on exhausted humans does not worsen markers of acidosis. Am J Emerg Med 27(4):413–418
69. Stutz N, Weiss D, Reichert B (2006) Lightning injuries: case report of a 17-year-old man and a brief review of the literature. Unfallchirurg 109(6):495–498
70. Sloane CM, Chan TC, Levine SD, Dunford JV, Neuman T, Vilke GM (2008) Serum troponin I measurement of subjects exposed to the Taser X-26. J Emerg Med 35(1):29–32
71. Rechtin C, Jones JS (2009) Best evidence topic reports. Bet 2: cardiac monitoring in adults after taser discharge. Emerg Med J 26(9):666–667
72. Link MS, Wang PJ, Pandian NG et al (1998) An experimental model of sudden death due to low-energy chest-wall impact (commotio cordis). N Engl J Med 338(25):1805–1811
73. Link MS, Maron BJ, Wang PJ, VanderBrink BA, Zhu W, Estes NA 3rd (2003) Upper and lower limits of vulnerability to sudden arrhythmic death with chest-wall impact (commotio cordis). J Am Coll Cardiol 41(1):99–104
74. Link MS, Estes NA 3rd (2007) Mechanically induced ventricular fibrillation (commotio cordis). Heart Rhythm 4(4):529–532
75. Geddes LA, Roeder RA (2005) Evolution of our knowledge of sudden death due to commotio cordis. Am J Emerg Med 23(1):67–75
76. Bozeman W, Winslow J, Hauda W, Graham D, Martin B, Heck J (2007) Injury profile of TASER® electrical conducted energy weapons (CEWs). Ann Emerg Med 50:S65
77. Strote J, Range Hutson H (2006) Taser use in restraint-related deaths. Prehosp Emerg Care 10(4):447–450

78. Fedorov V, Livshitz L, Kostecki G, Efimov I (2009) Electroporation of cardiac and nerve cells. In: Kroll M, Ho J (eds) TASER conducted electrical weapons: physiology, pathology, and law. Springer-Kluwer, New York City, pp 187–200
79. Panescu D, Kroll MW, Efimov IR, Sweeney JD (2006) Finite element modeling of electric field effects of TASER devices on nerve and muscle. Conf Proc IEEE Eng Med Biol Soc 1:1277–1279
80. Davalos RV, Mir IL, Rubinsky B (2005) Tissue ablation with irreversible electroporation. Ann Biomed Eng 33(2):223–231
81. Fahim K, Hauser C (2008) Taser use in man's death broke rules, police say. New York Times
82. Boyle J Man (2007) ignites in dispute. San Angelo Standard Times
83. Swerdlow CD, Fishbein MC, Chaman L, Lakkireddy DR, Tchou P (2009) Presenting rhythm in sudden deaths temporally proximate to discharge of TASER conducted electrical weapons. Acad Emerg Med 16(8):726–739
84. Nanji AA, Filipenko JD (1984) Asystole and ventricular fibrillation associated with cocaine intoxication. Chest 85(1):132–133
85. Raval M, Wetli C (1995) Sudden death from cocaine-induced excited delirium: an analysis of 45 cases. Am J Clin Pathol 104(3):329
86. Harrison D (2007) Science undecided on safety of stun guns. Can West News Service
87. Antoni H (1985) Pathophysiological basis of ventricular fibrillation. In: Bridges JF, Ford GL, Sherman IA, Vainberg M (eds) Electrical shock safety criteria. Pergammon Press, New York, pp 33–43
88. Antoni H (1998) Cardiac sensitivity to electrical stimulation. In: Reilly J (ed) Applied bioelectricity: from electrical stimulation to electrical pathology. New York, Springer, pp 194–239
89. Biegelmeier G (1987) Effect of current passing through the human body and the electrical impedance of the human body: a guide to IEC-Report 469. VDE, ETZ, Berlin, p 20
90. Biegelmeier G, Lee WR (1980) New considerations on the threshold of ventricular fibrillation for a.c.shocks at 50~60 Hz. IEE Proc 127(2 Pt A):103–110
91. Jacobsen J, Buntenkotter S, Reinhard HJ (1975) Experimental studies in pigs on mortality due to sinusoidal and phase-controlled alternating and rectified currents (author's transl). Biomed Tech (Berl) 20(3):99–107
92. Roy OZ, Park GC, Scott JR (1977) Intracardiac catheter fibrillation thresholds as a function of the duration of 60 Hz current and electrode area. IEEE Trans Biomed Eng 24(5):430–435
93. Sharma AD, Fain E, O'Neill PG et al (2004) Shock on T versus direct current voltage for induction of ventricular fibrillation: a randomized prospective comparison. Pacing Clin Electrophysiol 27(1):89–94
94. Swerdlow CD, Olson WH, O'Connor ME, Gallik DM, Malkin RA, Laks M (1999) Cardiovascular collapse caused by electrocardiographically silent 60-Hz intracardiac leakage current. Implications for electrical safety. Circulation 99(19):2559–2564
95. Weismuller P, Richter P, Binner L et al (1992) Direct current application: easy induction of ventricular fibrillation for the determination of the defibrillation threshold in patients with implantable cardioverter defibrillators. Pacing Clin Electrophysiol 15(8):1137–1143
96. Kroll M, Tchou P (2006) Testing of implantable defibrillator functions at implantation. In: Ellenbogen K, Kay G, Lau C, Wilkoff B (eds) Clinical cardiac pacing, defibrillation and resynchronization therapy, 3rd edn. W.B. Saunders Company, Philadelphia, pp 531–557
97. Singer I, Lang D (1996) The defibrillation threshold. In: Kroll M, Lehmann M (eds) Implantable cardioverter-defibrillator therapy: the engineering-clinical interface. Kluwer, Boston
98. Frame R, Brodman R, Furman S et al (1992) Clinical evaluation of the safety of repetitive intraoperative defibrillation threshold testing. Pacing Clin Electrophysiol 15(6):870–877
99. Schipke JD, Heusch G, Sanii AP, Gams E, Winter J (2003) Static filling pressure in patients during induced ventricular fibrillation. Am J Physiol Heart Circ Physiol 285(6):H2510–H2515
100. Yoon RS, DeMonte TP, Hasanov KF, Jorgenson DB, Joy ML (2003) Measurement of thoracic current flow in pigs for the study of defibrillation and cardioversion. IEEE Trans Biomed Eng 50(10):1167–1173

101. Camacho MA, Lehr JL, Eisenberg SR (1995) A three-dimensional finite element model of human transthoracic defibrillation: paddle placement and size. IEEE Trans Biomed Eng 42(6):572–578
102. Lerman BB, Deale OC (1990) Relation between transcardiac and transthoracic current during defibrillation in humans. Circ Res 67(6):1420–1426
103. Panescu D (2007) Less-than-lethal weapons: design and medical safety of neuromuscular incapacitation devices. IEEE Eng Med Biol Mag 26(4):57–67
104. Panescu D, Kroll M, Efimov I, Sweeney J (2006) Finite element modeling of electric field effects of TASER devices on nerve and muscle. Paper presented at: IEEE Engineering in Medicine and Biology. New York City
105. Stratbucker R, Kroll M, McDaniel W, Panescu D (2006) Cardiac current density distribution by electrical pulses from TASER devices. Paper presented at: IEEE Engineering in Medicine and Biology Society. New York City
106. Ferris LP, King BG, Spence PW, Williams HB (1936) Effect of electric shock on the heart. Electr Eng 55:498–515
107. Scott JR, Lee WR, Zoledziowski S (1973) Ventricular fibrillation threshold for AC shocks of long duration, in dogs with normal acid-base state. Br J Ind Med 30(2):155–161
108. Chilbert M (1998) Standards and rationale. In: Reilly J (ed) Applied bioelectricity: from electrical stimulation to electrical pathology. Springer, New York, pp 454–501
109. Russell S (2005) Heart expert warns about using Tasers. San Fransisco Chronicle
110. Garay A (2004) As orders soar, concern over stun guns soar. Associated Press. 30 Nov 2004
111. Schlosberg M (2005) Stun gun fallacy: how the lack of Taser regulation endangers lives. http://www.aclunc.org/issues/criminal_justice/police_practices/stun_gun_fallacy_how_the_lack_of_taser_regulation_endangers_lives.shtml
112. Hou CJ, Chang-Sing P, Flynn E et al (1995) Determination of ventricular vulnerable period and ventricular fibrillation threshold by use of T-wave shocks in patients undergoing implantation of cardioverter/defibrillators. Circulation 92(9):2558–2564
113. Schnabel PA, Richter J, Schmiedl A et al (1991) Patterns of structural deterioration due to ischemia in Purkinje fibres and different layers of the working myocardium. Thorac Cardiovasc Surg 39(4):174–182
114. Howe BB, Fehn PA, Pensinger RR (1968) Comparative anatomical studies of the coronary arteries of canine and porcine hearts. I. Free ventricular walls. Acta Anat (Basel) 71(1):13–21
115. Allison JS, Qin H, Dosdall DJ et al (2007) The transmural activation sequence in porcine and canine left ventricle is markedly different during long-duration ventricular fibrillation. J Cardiovasc Electrophysiol 18(12):1306–1312
116. Pak HN, Kim YH, Lim HE et al (2006) Role of the posterior papillary muscle and purkinje potentials in the mechanism of ventricular fibrillation in open chest dogs and Swine: effects of catheter ablation. J Cardiovasc Electrophysiol 17(7):777–783
117. Li GR, Du XL, Siow YL, O K, Tse HF, Lau CP (2003) Calcium-activated transient outward chloride current and phase 1 repolarization of swine ventricular action potential. Cardiovasc Res 58(1):89–98
118. Hamlin RL, Burton RR, Leverett SD, Burns JW (1975) Ventricular activation process in minipigs. J Electrocardiol 8(2):113–116
119. Kano M, Toyoshi T, Iwasaki S, Kato M, Shimizu M, Ota T (2005) QT PRODACT: usability of miniature pigs in safety pharmacology studies: assessment for drug-induced QT interval prolongation. J Pharmacol Sci 99(5):501–511
120. Dalziel CF, Lee WR (1968) Reevaluation of lethal electric currents. IEEE Trans Ind Gen Appl 4(5):467–476
121. Geddes LA, Cabler P, Moore AG, Rosborough J, Tacker WA (1973) Threshold 60-Hz current required for ventricular fibrillation in subjects of various body weights. IEEE Trans Biomed Eng 20(6):465–468
122. McDaniel WC, Stratbucker RA, Nerheim M, Brewer JE (2005) Cardiac safety of neuromuscular incapacitating defensive devices. Pacing Clin Electrophysiol 28(Suppl 1):S284–S287

123. Stratton SJ, Rogers C, Brickett K, Gruzinski G (2001) Factors associated with sudden death of individuals requiring restraint for excited delirium. Am J Emerg Med 19(3): 187–191
124. Dennis AJ, Valentino DJ, Walter RJ et al (2007) Acute effects of TASER X26 discharges in a swine model. J Trauma 63(3):581–590
125. Jauchem JR, Cook MC, Beason CW (2007) Blood factors of Sus scrofa following a series of three TASER((R)) electronic control device exposures. Forensic Sci Int. 175(2–3):166–170
126. Lakkireddy D, Wallick D, Verma A et al (2008) Cardiac effects of electrical stun guns: does position of barbs contact make a difference? Pacing Clin Electrophysiol 31(4):398–408
127. Walter RJ, Dennis AJ, Valentino DJ et al (2008) TASER X26 discharges in swine produce potentially fatal ventricular arrhythmias. Acad Emerg Med 15(1):66–73
128. Wu JY, Sun H, O'Rourke AP et al (2007) Taser dart-to-heart distance that causes ventricular fibrillation in pigs. IEEE Trans Biomed Eng 54(3):503–508
129. DiMaio T, Di Maio VJM (2006) Excited delirium syndrome cause of death and prevention. Taylor & Francis, Boca Raton
130. Pollanen MS, Chiasson DA, Cairns JT, Young JG (1998) Unexpected death related to restraint for excited delirium: a retrospective study of deaths in police custody and in the community. CMAJ 158(12):1603–1607
131. Allam S, Noble JS (2001) Cocaine-excited delirium and severe acidosis. Anaesthesia 56(4):385–386
132. Brice JH, Pirrallo RG, Racht E, Zachariah BS, Krohmer J (2003) Management of the violent patient. Prehosp Emerg Care 7(1):48–55
133. Wetli C (2006) Excited delirium. In: Chan R (ed) Sudden deaths in custody. Humana Press, Totawa, pp 99–112
134. Tabereaux PB, Walcott GP, Rogers JM et al (2007) Activation patterns of Purkinje fibers during long-duration ventricular fibrillation in an isolated canine heart model. Circulation 116(10):1113–1119
135. Mischke K, Schimpf T, Knackstedt C et al (2008) Efficacy of transesophageal defibrillation in ventricular fibrillation of long duration. Am J Emerg Med 26(3):287–290
136. Veltmann C, Borggrefe M, Schimpf R, Wolpert C (2007) Fatal inappropriate ICD shock. J Cardiovasc Electrophysiol 18(3):326–328
137. Kroll M, Panescu D (2011) Physics of electrical injury. In: Ho J, Dawes D, Kroll M (eds) Forensic medicine of conducted electrical weapons. Springer, New York City
138. Adams R (1955) Case of ventricular fibrillation of long duration with recovery; lessons from six cases in prevention and treatment. J Am Med Assoc 158(12):1026–1030
139. Holden SJ, Sheridan RD, Coffey TJ, Scaramuzza RA, Diamantopoulos P (2007) Electromagnetic modelling of current flow in the heart from TASER devices and the risk of cardiac dysrhythmias. Phys Med Biol 52(24):7193–7209
140. Ideker RE, Dosdall DJ (2007) Can the direct cardiac effects of the electric pulses generated by the TASER X26 cause immediate or delayed sudden cardiac arrest in normal adults? Am J Forensic Med Pathol 28(3):195–201
141. Dawes D, Ho J, Kroll M, Miner J (2010) Electrical characteristics of an electronic control device under a physiologic load: a brief report. Pacing Clin Electrophysiol. 33(3):330–336
142. Vilke GM, Sloane CM, Suffecool A et al (2009) Physiologic effects of the TASER after exercise. Acad Emerg Med 16(8):704–710
143. Dawes D, Ho J, Reardon R, Miner J (2009) Multiple simultaneous exposures of the TASER X26 in human volunteers. Europace 11:i49
144. Dawes DM, Ho JD, Reardon RF, Miner JR (2010) Echocardiographic evaluation of TASER X26 probe deployment into the chests of human volunteers. Am J Emerg Med 28(1):49–55
145. Reardon RF (2009) Echocardiographic effects of the CEW. In: Kroll M, Ho J (eds) TASER conducted electrical weapons: physiology, pathology, and law. Springer-Kluwer, New York City, pp 153–162
146. Ho JD, Dawes DM, Reardon RF et al (2008) Echocardiographic evaluation of a TASER-X26 application in the ideal human cardiac axis. Acad Emerg Med 15(9):838–844

147. Dawes DM, Ho JD, Reardon RF, Miner JR (2010) Echocardiographic evaluation of TASER X26 probe deployment into the chests of human volunteers. Am J Emerg Med. 28(1):49–55
148. Bozeman WP (2009) Additional information on taser safety. Ann Emerg Med 54(5):758–759
149. Main F (2005) Taser killed man, pathologist finds medical examiner's ruling on drug suspect first to blame stun gun. Chicago Sun Times
150. Jeffers G (2004) Medical examiner's sons charged; FBI agent beaten, city cop assaulted. Chicago Tribune
151. Kroll MW, Panescu D, Carver M, Kroll RM, Hinz AF (2009) Cardiac effects of varying pulse charge and polarity of TASER(R) conducted electrical weapons. Conf Proc IEEE Eng Med Biol Soc 1:3195–3198
152. Roy OZ, Scott JR, Park GC (1976) 60-Hz ventricular fibrillation and pump failure thresholds versus electrode area. IEEE Trans Biomed Eng 23(1):45–48
153. Kroll M, Panescu D, Hinz A, Lakkireddy D (2010) A novel mechanism for electrical currents inducing ventricular fibrillation: The three-fold way to fibrillation. Engineering in Medicine and Biology Society Proceedings. 1990–1996
154. Nimunkar A, Wu J, O'Rourke A, Huebner S, Will J, Webster J (2010) Ventricular fibrillation and blood chemistry after multiple Tasering of Pigs. Physiol Meas
155. Dawes DM, Ho JD, Reardon RF, Miner JR (2010) Echocardiographic evaluation of TASER X26 probe deployment into the chests of human volunteers. Am J Emerg Med. 28(1):49–55
156. Strote J, Verzemnieks E, Walsh M, Hutson HR (2010) Use of force by law enforcement: an evaluation of safety and injury. J Trauma. 69(5):1288–1293
157. Smith M, Kaminski R, Rojek J, Alpert G, Mathis J (2007) The impact of conducted energy devices and other types of force and resistance on officer and suspect injuries. Policing Int J Police Strateg Management 30(3):423–446
158. Brewer J, Kroll M (2009) Field statistics overview. In: Kroll M, Ho J (eds) TASER conducted electrical weapons: physiology, pathology, and law. Springer-Kluwer, New York City
159. Valentino DJ, Walter RJ, Dennis AJ et al (2008) Acute effects of MK63 stun device discharges in miniature swine. Mil Med 173(2):167–173
160. Ewy GA, Zuercher M, Hilwig RW et al (2007) Improved neurological outcome with continuous chest compressions compared with 30:2 compressions-to-ventilations cardiopulmonary resuscitation in a realistic swine model of out-of-hospital cardiac arrest. Circulation 116(22):2525–2530
161. DiMaio V, DiMaio T (2009) Excited delirium syndrome. In: Kroll M, Ho J (eds) TASER conducted electrical weapons: physiology, pathology, and law. Springer-Kluwer, New York City, pp 347–363
162. Park KS, Korn CS, Henderson SO (2001) Agitated delirium and sudden death: two case reports. Prehosp Emerg Care 5(2):214–216
163. Wu J, Sun H, O'Rourke A et al (2009) Taser blunt probe dart-to-heart distance causing ventricular fibrillation in pigs. IEEE Trans Biomed Eng. 55(12):2768–2771
164. Kroll MW, Calkins H, Luceri RM, Graham M, Heegaard W (2008) Sensitive swine and TASER electronic control devices. Acad Emerg Med 15(7):695–696

Chapter 9
Care of Detainees

Margaret M. Stark and Guy A. Norfolk

Introduction

Healthcare professionals (HCPs) may be asked by the police to assess the fitness for detention in police custody of adults and juveniles arrested in connection with an offense; those detained by immigration; individuals requiring a place of safety (children and the mentally ill); remanded or sentenced (convicted) prisoners; or those detained under terrorism legislation. A person in police custody is referred to as a detainee in this chapter. Detainees may have to be interviewed regarding their involvement in an offense and possibly further detained overnight for court; guidance may therefore have to be given to the custodians regarding their care.

Although various laws govern the powers of the police in different jurisdictions [1], the basic principles remain the same [2–4]. It is essential that custody staff perform a risk assessment when an individual is detained in police custody [5] as a significant amount of health morbidity exists among this group [6]. If an individual is identified to be suffering from a mental or physical illness and needs medical attention or has sustained any injuries whether at arrest or prior to arrest, such attention should be sought as soon as possible [7]. Increasingly, the police have to deal with individuals who misuse alcohol and drugs or are mentally disordered; if the detainee's behavior gives rise to concern, medical advice should be sought [8].

Custody staff should also seek medical advice if an individual requests a doctor or requires medication or if the custody staff suspects that the detainee is suffering from an infectious disease and need advice. In some areas, when a person under arrest is

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Table 9.1 Briefing on arrival

Discuss reason called (physical or mental illness/medication/injuries)
Obtain details from the custody record and from any risk assessment performed by police personnel or other healthcare professional, including the reason for arrest (may be related to drugs)
Ask the arresting officer for information regarding the circumstances of arrest (concerns regarding behavior/use of force)
Other information may be obtained from relatives/friends/family doctor/hospital/police national computer/database
Whether any force was used: handcuffs, incapacitant spray, batons, TASER, etc.
Whether anything found in the detainee's property or when searched (medication, illicit drugs)
Any concerns about detainee's behavior or personal safety
Is request to assess fitness for detention only?
The anticipated length of detention if known, is the detainee likely to in custody overnight
Is the detainee to be interviewed?
Are any forensic samples required?

discharged from the hospital and taken to a police station, a HCP will be called for advice as to whether the detainee is fit to be detained and fit for interview.

Assessments of detainees may be performed by a healthcare professional with the appropriate skills: a doctor, nurse, or paramedic retained to attend the police station [9–12] or by staff in the local hospital accident and emergency department [13]. The basic principles on which doctors should base their conduct have already been outlined in Chap. 2.

In 2003, the term healthcare professional was introduced in the UK. It refers to a:

> Clinically qualified person, who is working within the scope of practice as determined by their relevant professional body and who is registered with that body as competent to practice. [14]

This term has been used in the Codes of Practice since 2003. This now means that multidisciplinary teams can work within police custody in the UK. However, it is essential that any initial training is to the required standard and continuing professional development is maintained. National Occupational Standards have been defined for the healthcare service provision in police custody [15]. HCPs working in police custody, a lone and autonomous role professionally, should be supported by robust clinical governance procedures to ensure competence in this high-risk environment [16, 17].

The health and welfare of detainees should be paramount, with any forensic considerations of secondary importance. The role of any healthcare professional in this field should be independent, professional, courteous, and nonjudgmental [18, 19].

If the police bring a detainee to the emergency department or if the HCP is contacted by the police to attend the police station, it is important to find out the reason why a medical assessment is required. It is essential that the HCP be properly briefed by the custody staff or investigating officer (Table 9.1).

Fully informed consent from the detainee should be obtained after explaining the reason for the examination. The Faculty of Forensic and Legal Medicine of the Royal College of Physicians of London have several pro formas for such forensic

Table 9.2 The drugs mnemonic

Doctor	Any medication prescribed by a registered medical or dental practitioner
Recreational	Tobacco, alcohol, illicit drugs, anabolic steroids, etc.
User	Over the counter purchases/alternative medicine/homeopathy
Gynecological	Contraceptive or hormone replacement treatment
Sensitivities	Including the exact nature of the response

From Hocking et al. [20]

examinations and for obtaining consent that are readily available to all HCPs (www.fflm.ac.uk). Detainees should understand that they are under no obligation to give consent and that there is no right to absolute confidentiality. Notwithstanding the latter, custody staff should only be given the information necessary for them to care for detainees while they are in police detention. Such information will include details of any medical concerns, required observations, medication, and dietary requirements.

Although those detained in police custody are usually young, there remains the potential for considerable morbidity and mortality among this group. Therefore, it is essential that a full medical assessment be performed and detailed contemporaneous notes made. Obtaining an accurate account of a detainee's drug history, including prescribed and illicit drugs, can be difficult. A useful aid to obtaining a better drug history has been described (Table 9.2) [20].

Administration of Medication

The doctor should ensure that clear and detailed instructions regarding any medication to be administered while the detainee is in police custody (including the dose, times of administration, and special instructions) are given to custodians with confirmation that these instructions are understood [21]. Recent changes to legislation in the UK [22, 23] have allowed nurses and paramedics to use Patient Group Directions defined as:

> a written instruction for the supply and/or administration of a licensed medicine (s) in an identified clinical situation signed by a doctor or dentist and a pharmacist. It applies to groups of patients who may not be individually identified before presenting for treatment. [24]

A sufficient quantity of medication should be prescribed to cover the time in detention. The medication should be given to the police in appropriately labeled individual containers or sachets; alternatively, medication may be prescribed and collected from the local pharmacist.

It is most important that there be a safe regime for the administration of medication to detainees. Records should be kept showing that the prescribed medication is given at the correct time and that any unused medicines are accounted for. Medication should be stored in a locked cupboard. Ideally, police personnel should ensure that when administering medication, they are accompanied by another person as a witness and the detainee should be observed taking the medication to prevent hoarding.

If detainees are arrested with medications on their persons, medical advice should be sought as to whether they should be allowed to self-administer them. It may be prudent for an assessment by a doctor to be performed either in the custody suite or in the local hospital prior to self-administration.

Medication brought with the prisoner or collected from the home address should be checked to ensure that it has the correct name and dosage and that the quantity left is consistent with the date of issue. If there is doubt, checks should be made with the pharmacist, family doctor, or hospital. If the medicine is unlabeled, it is preferable to issue a new prescription, especially with liquid preparations such as methadone. Consideration should be given to supervising injections such as insulin.

Conditions of Detention

The doctor should ensure that the conditions of detention are satisfactory with regard to the temperature and ventilation of the detention cells, cleanliness of the cell, bedding, personal hygiene, dietary needs, and fluids [4, 25]. The detainee should have access to food and fluids as appropriate and should also have a period of rest of 8 h during each 24 h.

Medical Problems

A number of common medical problems are encountered when the doctor is assessing fitness to be detained in police custody. These are now considered in more detail (Table 9.3). Alcohol and drugs are fully discussed in Chap. 12.

Table 9.3 Common medical problems

Epilepsy
Asthma
Diabetes
Heart disease
Sickle cell disease
Injuries
Infectious diseases
Mental health
Self-harm
Claustrophobia
Pregnancy
Detainees who refuse nourishment
Alcohol/drugs

Epilepsy

Many detainees state that they have "fits" and there is a need to differentiate, if possible, between epilepsy and seizures related to withdrawal from alcohol or benzodiazepines; it is also important to consider hypoglycemia.

The type of seizure should be ascertained together with the frequency and date of the most recent one. Details of medication should be obtained including time of the last dose. Treatment may be given if the detainee is in possession of legitimate medication; however, if he or she is intoxicated with alcohol or other central nervous system depressant drugs, treatment should generally be deferred until the detainee is no longer intoxicated.

The custody staff should have basic first aid skills to enable them to deal with medical emergencies such as what to do when someone has a fit. If a known epileptic has a seizure while in custody, a medical assessment is advisable, although there is probably no need for hospitalization. However, if a known epileptic has more than one fit or a detainee has a "first-ever" fit while in custody, then transfer to a hospital is recommended.

In custody, HCPs should have access to rectal diazepam for prolonged or repeated seizures [26, 27]. Any detainee requiring parenteral medication to control fits should be observed for a period in the hospital.

Asthma

Asthma is a common condition; a careful history, including asking about recent exacerbations and hospital admissions, and objective recording of simple severity markers such as pulse and respiratory rate, blood pressure, speech, chest auscultation, mental state, and peak expiratory flow rate should identify patients who require hospitalization or urgent treatment [28, 29]. Asthmatics should be allowed to retain bronchodilators, after a risk assessment, for the acute relief of bronchospasm, e.g., salbutamol or the equivalent, with instructions left with the custody sergeant on other treatment if required. Any inhaler should be checked before being left with the detainee.

Custody staff may confuse hyperventilation for asthma in the custodial setting which may be feigned to attempt diversion. The HCP should perform a detailed assessment regarding management, as if there was a panic attack, this would suggest the need for a further mental health assessment. Often reassurance is all that is required to calm the detained person, but in severe cases rebreathing techniques may need to be used.

Diabetes

It is often desirable to obtain a baseline blood glucose measurement when diabetic detainees are initially assessed and for this to be repeated if necessary throughout the period of detention. All doctors should have the means to test blood glucose, using either a strip for visual estimation or a quantitative meter. A wide range of small portable meters is now available.

Oral hypoglycemics and insulin should be continued and consideration given to supervision of insulin injections. Regular meals and snacks should be provided, and all diabetic patients should have access to rapidly absorbed carbohydrate-rich food.

Hypoglycemia is easily treated [30]: if the blood glucose is less than 4 mmol/L in a conscious person, oral carbohydrate should be given. In an unconscious or restless detainee, an intravenous bolus of 50 mL of 50% dextrose solution may be difficult to administer and may result in skin necrosis if extravasation occurs; therefore, glucagon 1 mg can be given intramuscularly followed by 40% glucose gel orally or applied to the inside of the mouth. Glucagon can give an initial glycemic response even in a patient with alcoholic liver disease [31]; however, it should be remembered that in severe alcoholics with depleted glycogen stores, the response to glucagon may be reduced or ineffective.

Heart Disease

The main problems encountered include a history of hypertension, angina, cardiac failure, and stable dysrhythmias. Basic cardiovascular assessment may be required including examination of the pulse and blood pressure together with auscultation of the heart and lungs for evidence of murmurs or cardiac failure.

Prescribed medication should be continued, and detainees should be allowed to keep their glyceryl trinitrate (GTN) spray or tablet with them in the cell. Chest pain that does not settle with GTN will obviously require further assessment in the hospital [32].

Sickle Cell Disease

Most detainees with sickle cell disease are aware of their illness and the symptoms to expect during an acute sickle cell crisis. Medical management in custody should not pose a problem unless there is an acute crisis, when hospital transfer may be required. Conditions of detention should be suitable, with adequate heating and access to fluids and analgesics as appropriate.

General Injuries

Detailed documentation of injuries is an important and common request. The injuries may have occurred prior to or during the arrest, and documentation of such injuries may form part of the investigation to refute counter allegations of assault.

Table 9.4 Head injuries indications for hospital assessment

A head-injured patient should be referred to hospital if any of the following are present (a head injury is defined as any trauma to the head, other than superficial injuries to the face)
Impaired consciousness (Glasgow Coma Score <15/15) at any time since injury
Any focal neurological symptoms or signs (e.g., problems understanding, speaking, reading, or writing; decreased sensation; loss of balance; general weakness; visual changes; abnormal reflexes; and problems walking)
Any suspicion of a skull fracture or penetrating injury (e.g., CSF leak; black eye with no associated damage around the eyes; bleeding from or new deafness in one or both ears; mastoid hematoma; signs of penetrating injury; visible trauma to the scalp or skull of concern to the FP)
Pre- or posttraumatic amnesia
Persistent headache since the injury
Any vomiting since the injury
Any seizures since the injury
Medical comorbidity (e.g., previous cranial surgery; anticoagulant therapy; bleeding or clotting disorder)
High-energy head injury (e.g., fall from height of more than 1 m or five stairs)
Current drug or alcohol intoxication
Significant extracranial injuries
Continuing uncertainty about the diagnosis after first assessment
Age greater than 65 years

From Payne-James and Wyatt [38]

A record of each injury as outlined in Chap. 4 should be made and basic first aid provided. Certain wounds may be treated with Steristrips or Histoacryl glue in the police station [33], although occasional transfer to a hospital will be required for further medical assessment, e.g., wound toilet, suturing, X-rays.

Head Injuries

Any suspected head injury should receive a detailed assessment [34]. The time, place, and nature of the injury should be ascertained from the detainee or from any witnesses who were present. The duration of any loss of consciousness and the behavior since the injury should be noted. Examination should include measurement of pulse and blood pressure, Glasgow Coma Scale [35] (Appendix 1), and neurologic assessment. The indications for hospital assessment include situations in which there are problems with the assessment of the patient or an increased risk of skull fracture or an intracranial bleed [36].

Ingestion of alcohol or drugs and relevant past medical history should be ascertained. Although deaths in police custody are rare, head injuries accounted for 10% and substance abuse, including alcohol and drugs, accounted for 25% in a survey of such deaths between 1990 and 1997 in England and Wales [37]. There should be a low threshold for referral to hospitals, especially if a detainee with a head injury is also under the influence of alcohol or drugs.

If the detainee is to remain in custody, then instructions regarding the management of head-injured patients should be left verbally and in writing with the custody staff and given to the patient on release (Table 9.4) [38]. Police should be advised particularly that when checking a detainee's conscious level they are required to rouse and speak with the detainee, obtaining a sensible response. Appendix 1 outlines the Glasgow Coma Scale and an observation checklist for custody staff responsible for the health care of detainees.

Infectious Diseases

The doctor may be called to advise the police regarding infectious diseases. This subject is now covered fully in Chap. 10. As the population in police custody could be seen as high risk for blood-borne viruses such as hepatitis and the human immunodeficiency virus [39], all individuals should be considered a potential risk, and observation of good clinical practice relating to body fluids, universal precautions, to avoid contamination is essential [40].

Mental Health

General Psychiatric Problems

It is essential that the police are trained to recognize those detainees with mental health problems or intellectual disabilities (see Section "Intellectual Disabilities") at point of contact [41], but also on detention when carrying out a risk assessment [6]. When a psychiatric disorder is suspected, the custody staff should consider whether a HCP should be called to perform a full assessment involving background information, full psychiatric history if known, observation of the detainee, and mental state examination (Table 9.5; see Appendix 2) to assess whether there is in fact any evidence of mental illness.

The nurse or paramedic should refer those detainees where they have concerns regarding their mental state to the forensic physician who should then consider whether diversion from the criminal justice system is appropriate. If the detainee has committed a minor offense and there is only evidence of minor-to-moderate mental illness, treatment may be arranged in the community, in outpatients, or in the day hospital. If, however, the detainee is found to have an acute major mental illness, but has only committed a minor or moderate offense, then admission to the hospital for further assessment and treatment will be required either informally or if necessary formally. When the offense is more serious and there is evidence of probable mental

Table 9.5 Brief mental state examination

Appearance – self-care, clothing, facial
Behavior – withdrawn, aggressive, disinhibited
Speech – rate, volume
Thought – association, content (delusions)
Perception – hallucinations, illusions
Obsessive/compulsive behaviors
Mood – depression, anxiety, elation,
Biological symptoms (sleep, appetite, energy)
Cognitive function – orientation, short-term memory, concentration, long-term memory
Risk behaviors – self-harm, harm to others

illness needing further assessment, then the detainee may need to go before the court for such an assessment to be ordered.

Chronic stable mental health problems usually pose no specific problems for police detention, but may require specific safeguards when the detainee is to be interviewed by the police (see Chap. 11). Long-term medication should be continued.

Individuals with attention deficit hyperactivity disorder (ADHD) and attention deficit disorder (ADD) may not be easily recognized by custody staff and yet because of confrontational behavior may come to notice of the police. ADHD is associated with early offending and repeat offending into adult life [42]. Detainees with autism and Asperger's syndrome, part of the autistic spectrum disorders (ASD), developmental conditions, may have difficulties in social situations and with communication in custody environment.

Substance Misuse and Mental Illness

Concurrent substance misuse and mental illness – "dual diagnosis" or "co-morbidity" – is an important consideration. In the Epidemiologic Catchment Area (ECA) study, 29% of individuals with a lifetime history of any mental disorder (other than substance use) had a history of substance use (22% alcohol disorder and 15% a drug disorder) [43]. In a more recent study [44] of patients accessing community mental health teams and substance misuse services in urban UK centers, 44% reported past-year problem drug use and/or harmful alcohol use; 75% of drug service and 85% of alcohol service patients had a past-year psychiatric disorder.

Comorbidity can be classified on the basis of the primary diagnosis [45, 46]. There are those with a primary diagnosis of a major mental illness who have a secondary diagnosis of substance misuse that further affects their mental health. Such individuals may use drugs to relieve the adverse symptoms of their mental illness. Conversely, substance misuse may be the primary diagnosis leading to psychiatric complications and mental illness – for example, depression with suicidal ideation may occur among substance misusers. On occasions, mental illness and substance misuse may coexist together such as when an underlying traumatic experience results in both substance misuse and posttraumatic stress disorder.

Deliberate Self-Harm

Research has shown that episodes of deliberate self-harm (DSH) typically occur soon after arrest. Particular risk factors include a previous history of DSH and a past psychiatric history [47, 48]. Medical assessments should be requested for those detainees who give a clear intention of DSH with attention given to any visible evidence of previous acts of DSH.

If a detainee commits an act of DSH, a medical assessment should be carried out irrespective of whether there has been any physical injury, and an attempt should be made to assess the risk of suicide [49]. When the risk is thought to be high, then referral to a hospital will be required and the detainee should be kept under constant supervision until such transfer is arranged. When the risk is deemed to be low, clear instructions will need to be given to the police regarding care and supervision. The police may consider removal of the detainee's clothing and personal effects to prevent self-harm. Cells should be checked with respect to their structural integrity to prevent any defects being used for DSH, and bedding should be of an appropriate standard.

Liaison between agencies is essential, and when the detainee is transferred to prison, another police station, or hospital, details regarding the DSH incident should be passed to the custody or hospital staff concerned so they can take appropriate precautions.

Claustrophobia

Claustrophobia is a common complaint, and a detailed history and examination with an emphasis on the presence or absence of anxiety when faced with the problem in everyday life should be sought. An enquiry regarding behavior at home, such as leaving doors and windows open, avoidance of elevators and underground trains, and a history of the original precipitant for such behavior should be noted.

Often reassurance is enough, and it is rarely necessary to give any medication. The custody staff should be advised if genuine claustrophobia is suspected as this may affect the detainee's fitness to be interviewed.

Personal Safety Issues

Certain healthcare groups are at increased risk of violence in the workplace, for example, those working in the custodial environment [50] or accident and emergency services [51].

There are a number of strategies for interviewing a difficult patient [52], which include being fully aware of the person's history (be prepared!), and considering how the person sees you (as uninterested or hostile?), being polite and respectful, avoiding confrontation, using appropriate eye contact, keeping calm, and showing interest. Look for signs of tension and find out why tension may be increasing. Finally, be ready to leave if necessary and consider the need to have a chaperone (appropriately trained in restraint techniques) of the same sex as the patient to be examined.

Accurate assessment regarding the possibility of violence will reduce the danger, but it should never be assumed that there is no risk, and every clinical situation should be categorized as high risk due to an obvious risk or unknown risk due to undiscovered factors [53].

Drug Searches

Persons unlawfully in possession of illicit drugs for personal use or involved in drug supply or trafficking may ingest drugs or pack them into certain body cavities ("body packers" or "mules"). Third parties may be employed to act as mules and a case of body packing using children, two boys aged 6 and 12, who had concealed heroin has been reported [54].

A person who is about to be arrested by the police may swallow drugs "body swallower," "stuffer," or "contact precipitated concealer." Individuals who have recently swallowed drugs should be taken immediately to an emergency department for full risk assessment [5].

HCPs may be called by the police to carry out intimate searches of those arrested (see Chap. 2) [55]. Any healthcare professional who agrees to perform an intimate search should have the required skills and a comprehensive understanding of the risks involved and their management. The HCP should discuss the possible implications of the ingestion of certain drugs and obtain fully informed consent from the detainee before carrying out any search that may involve examination of the mouth, nostrils, ears, umbilicus, foreskin, rectum, or vagina.

Variable quantities of drugs such as heroin, cocaine, cannabis, and amphetamine may be packaged in layers of cellophane or in condoms. All searches for such drugs should be carried out in premises where there are full facilities for resuscitation [56] in case significant quantities of the drugs leak into the bloodstream, resulting in acute intoxication and death from overdose [57, 58]. Other medical problems such as bowel obstruction may also occur.

The aim of medical management is to prevent these complications, but for ethical reasons the retrieval of packages for legal purposes alone is no indication for intervention without the patient's permission. Therefore, without such permission, the doctor can do nothing except advise the police authorities that the detainee should be observed. In most asymptomatic patients, a trial of conservative treatment, provided bowel obstruction or package perforation is not suspected, will result in the uncomplicated elimination of all ingested packages [59, 60].

In a genuine emergency, when there is no possibility of obtaining consent, the doctor has a duty to carry out treatment to safeguard the life and health of a patient in accordance with what would be accepted as appropriate treatment in the patient's best interests [61].

However, body stuffers can develop symptoms hours after ingestion with delayed toxicity leading to death. A fatal case report of a cocaine body stuffer concluded that the integrity of the packaging has an important predictive value in determining the time and likelihood of toxicity [62]. A nonfatal case of significantly delayed toxicity has also been reported [63].

Forensic Samples

Samples from a detainee such as dental impressions, blood, saliva, urine, hair, fingernail scrapings and cuttings, and swabs (e.g., mouth, penile) may be requested by police authorities in connection with the investigation of an offense. These samples should only be taken by a HCP for evidential purposes with the detainee's fully informed consent and should be packaged in accordance with local procedures to ensure the chain of evidence. For further details regarding samples see Chap. 3.

Pregnancy

It is not uncommon to have pregnant detainees in police custody or individuals who state that they are pregnant to attempt to seek diversion. Access to on-site pregnancy testing kits is an advantage. Irregular menses are common in substance misusers, especially those dependent on opiates [64]. The HCP will need to assess each case and decide whether to recommend detention or transfer for obstetric assessment. Extreme caution is required in prescribing medication, especially substitute prescribing.

It is essential to take detailed history of the pregnancy, the last menstrual period, estimated date of delivery, previous pregnancies, and outcomes. Specific enquiry should be made about the presence of fetal movements, abdominal pain, or bleeding per vagina. Occasionally, pregnant detainees may not have had any contact with local services such as antenatal, and drug services if required, and this consultation is an opportunity for intervention. There should be a low threshold for referral to hospital.

Detainees Who Refuse Nourishment

The HCP may have to advise custody staff regarding a detainee's diet or where there are cultural issues. If a detainee refuses food for 24 h, the HCP should be called to assess the detainee as to the capacity to make such a decision and should explain to the detainee the consequences of self-starvation. If the detainee refused fluids, then he/she should be seen more regularly as the physical and mental state of the detainee may deteriorate quickly.

Terrorist Detainees

HCPs may be asked to assess individuals detained under terrorism legislation. Forensic physicians should perform this assessment and outline a management plan for the multidisciplinary team [65]. The same general principles apply, but it should be remembered that terrorist detainees may be held for longer periods of time and in solitary confinement as defined by the Istanbul statement as the physical isolation of individuals who are confined to their cells for 22–24 h a day [66]. It is essential that a high standard of care and ethical behavior is maintained by HCPs, including providing advice on the physical conditions and overall regime [67].

Intellectual Disabilities

Intellectual disability is characterized by a significantly below-average score on a test of mental ability or intelligence and by limitations in the ability to function in areas of daily life, such as communication, self-care, and getting along in social situations and school activities [68]. Intellectual disability is also sometimes referred to as a cognitive disability or mental retardation and may range from mild to severe. A person's level of intellectual disability can be defined by their intelligence quotient (IQ), or by the types and amount of support they need.

It is important to identify individuals with intellectual disabilities, so precautions can be put in place to protect them while detained in police custody (see also Chap. 11). Intellectual disabilities should not be confused with "learning difficulties" which does not imply any disorder and usually refers to problems with learning such as dyslexia. Although there is no easy way to recognize individuals with such disabilities, questions regarding employment, schooling, reading, writing and telling the time, contact with relevant services/agencies, as well as enquiry as to whether the individual lives independently may assist in identifying this vulnerable group.

Appendix 1: Glasgow Coma Scale

Glasgow Coma Scale	Score
Eye opening	
Spontaneous	4
To speech	3
To painful stimulus	2
None	1
Best motor response	
Obeys commands	6
Localizes painful stimulus	5
Withdraws (normal flexion)	4
Flexes abnormally (spastic flexion)	3
Extension	2
No response	1
Best verbal response	
Orientated	5
Confused	4
Says inappropriate words	3
Makes incomprehensible sounds	2
No verbal response	1
Maximum	15

From Jennett and Teasdale [35]

Detained Person: Observation List

1. If any detainee fails to meet any of the following criteria, an appropriate health-care professional or ambulance must be called.
2. When assessing the level of rousability consider:

   Rousability – can they be woken?

   - Go into the cell
   - Call their name
   - Shake gently

   Response to questions – can they give appropriate answers to questions such as:

   - What's your name?
   - Where do you live?
   - Where do you think you are?

   Response to commands – can they respond appropriately to commands such as:

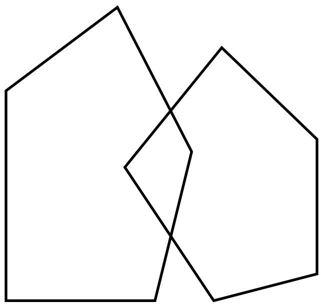
   - Open your eyes!
   - Lift one arm, now the other arm!

   Remember – take into account the possibility or presence of other illnesses, injury, or mental condition, a person who is drowsy and smells of alcohol may also have the following:

   - Diabetes
   - Epilepsy
   - Head Injury
   - Drug intoxication or overdose
   - Stroke

   From: Home Office. Code C. Annex H [1]

Appendix 2: The Mini-Mental State Examination

	Score
Orientation	
What is the (year) (season) (date) (day) (month)	…./5
Where are we: (country) (state) (county) (town) (police station)	…./5
Registration	
Examiner names three objects (e.g., orange, key, ball)	
Patient asked to repeat the three names	
Score one for each correct answer	…./3
Then ask the patient to repeat all three names three times	
Attention	
Serial 7's. Stop after 5 correct answers	
Alternatively, if patient makes errors on serial subtraction: spell	
"world" backwards: D L R O W	
Score best performance on either task	…./5
Recall	
Ask for the names of the objects learnt earlier	…./3
Language	
Show and ask the patient to name a pencil and a watch	…./2
Repeat the phrase "No ifs, and, or buts"	…./1
Give a three-stage command. Score one for each stage (e.g., "Take this piece of paper in your right hand, fold it in half, and place it on the chair next to you")	…./3
Ask patient to read and obey a written command on a piece of paper stating: "Close your eyes"	…./1
Ask the patient to write a sentence. Score correct if it has a subject and a verb	…./1
Copying	
Ask patient to copy intersecting pentagons. Score as correct if they overlap and if each has five sides	…./1
	
Total score	…./30

From Folstein et al. [69]

References

1. Police and Criminal Evidence Act 1984 (s.60 (1) (a), s.60A (1) and s.66 (1)) Codes of Practice A-G 2005 for England and Wales. Her Majesty's Stationery Office, Norwich, 2006
2. British Medical Association Medical Ethics Department and Faculty of Forensic and Legal Medicine (2009) Health care of detainees in police stations. British Medical Association, London
3. Stark MM, Rogers DJ, Norfolk GA (2009) Good practice guidelines for forensic medical examiners. Royal Military Police, GPG Editors, Oxford
4. Council of Europe (2006) European Committee for the prevention of torture and inhuman or degrading treatment or punishment (CPT). The CPT standards www.cpt.coe.int/en/documents/eng-standa
5. ACPO, Home Office, Centrex (2006) Guidance on the safer detention & handling of persons in police custody. NPIA, Wyboston
6. McKinnon I, Grubin D (2010) Health screening in police custody. J Forensic Leg Med 17:209–212
7. Payne-James JJ, Green PG, Green N, Munro MHWM, Moore TCB (2010) Healthcare issues of detainees in police custody in London, UK. J Forensic Leg Med 17:11–17
8. McMillan R, Stark MM (2010) HCP examination of detainees in custody. Guidance for custody staff. Metropolitan Police Service, London
9. Payne-James JJ (1992) Work patterns of a forensic medical examiner for the Metropolitan Police. Police Surg 42:21–24
10. Young S, Wells D, Jackson G (1994) A tiered health care system for persons in police custody – the use of a forensic nursing service. J Clin Forensic Med 1:21–25
11. Webb V, Stark MM, Cutts A, Tait S, Randle J, Green G (2010) One model of health care provision – lessons learnt through clinical governance. J Forensic Leg Med 17:368–373
12. Payne-James JJ, Anderson WR, Green PG, Johnston A (2009) Provision of forensic medical services to police custody suites in England and Wales: current practice. J Forensic Leg Med 16:189–195
13. Smock WS (1994) Development of a clinical forensic medicine curriculum for emergency physicians in the USA. J Clin Forensic Med 1:27–30
14. Home Office Circular (02/2003) Healthcare professionals in custody suites – guidance to supplement revisions to the codes of practice under the Police and Criminal Evidence Act 1984. 2008 Mannheim Centre for Criminology (London, England) www.homeoffice.gov.uk
15. Functional Map for HCP working in Police Custody settings. Skills for Health, 2007. www.skillsforhealth.org.uk
16. Stark MM (2000) The medical care of detainees and the prevention of tragedy – the role of the forensic medical examiner. Clin Risk 7:15–19
17. Payne-James JJ (2010) Clinical risk and detainees in police custody. Clin Risk 16:56–60
18. Sarkar U, Stark MM (2010) The role of the independent Forensic Physician. FFLM. www.fflm.ac.uk
19. Randle J, Fewkes S, Stark MM (2010) The role of healthcare professional. FFLM. www.fflm.ac.uk
20. Hocking G, Kalyanaraman R, deMello WF (1998) Better drug history taking: an assessment of the DRUGS mnemonic. J R Soc Med 91:305–306
21. Cooke C, Payne-James JJ (2011) Safe and secure administration of medication in police custody. Recommendations. FFLM. www.fflm.ac.uk
22. Home Office circular 026/2003. Patient group directions. www.homeoffice.gov.uk
23. MHRA (2010). Patient Group Directions in the private sector. www.mhra.gov.uk
24. National Prescribing Centre (2009) Patient Group Directions. A practical guide and framework of competencies for all professionals using patient group directions. www.npc.co.uk
25. Howitt J (1995) Poor conditions of detention compromise ethical standards. J R Soc Med 88:40P–41P
26. Brodie MJ (1990) Status epilepticus in adults. Lancet 336:551–552

27. The National Institute for Clinical Excellence (NICE) (2004) The epilepsies: diagnosis and management of the epilepsies in adults in primary and secondary care. CG 20 Quick reference guide. www.nice.org.uk. Accesssed Oct 2004
28. Mathur R, Bell D (1996) Asthma management in police study. J Clin Forensic Med 3:133–140
29. British Thoracic Society/Scottish Intercollegiate Guidelines Network (BTS/SIGN) (2009) British guideline on the management of asthma, quick reference guide. www.sign.ac.uk. Accessed June 2009
30. Hypoglycaemia – treatment in diabetic patients. http://healthguides.mapofmedicine.com/choices/map/hypoglycaemia4.html
31. Heller MB, Vukmir RB (1992) Glucagon for metabolic/endocrinologic emergencies: hypoglycaemia. In: Picazo J (ed) Glucagon in acute medicine. pharmacological, clinical and therapeutic implications. Kluwer Academic, London
32. The National Institute for Clinical Excellence (NICE) (2010) Chest pain of recent onset. CG 95 Quick reference guide. www.nice.org.uk. Accessed Mar 2010
33. Payne-James JJ (1993) The role of cyanoacrylate tissue adhesive (Histoacryl blue) in forensic medical practice. Police Surg 43:30–31
34. Marks PV (1994) Acute head injury: assessment and practical management. J Clin Forensic Med 1:43–46
35. Jennett B, Teasdale G (1977) Aspects of coma after severe head injury. Lancet i:878–881
36. The National Institute for Clinical Excellence (NICE) (2007) Head injury. Triage, assessment, investigation and early management of head injury in infants, children and adults. CG 56 Quick reference guide. www.nice.org.uk. Accessed Sept 2007
37. Leigh A, Johnson G, Ingram A (1998) Deaths in police custody: learning the lessons, Police Research Series Paper 26. Police Research Group Publications, Home Office, London
38. Payne-James JJ, Wyatt J (2007) Head injury warning. FFLM www.fflm.ac.uk
39. Payne-James JJ, Keys DW, Wall I, Dean PJ (1994) Prevalence of HIV factors for individuals examined in clinical forensic medicine. J Clin Forensic Med 1:93–96
40. UK Health Departments (1998) Guidance for clinical health care workers: protection against infection with blood-borne viruses. Department of Health, London
41. ACPO, DH, NPIA (2010) Guidance on responding to people with mental ill health or learning disabilities. NPIA, London
42. Young S (2007) Forensic aspects of ADHD. In: Fitzgerald M, Bellgrove M, Gill M (eds) Handbook of attention deficit hyperactivity disorder. Wiley, Hoboken
43. Regier DA, Farmer ME, Rae DS, Locke BZ, Keith SJ, Judd LL et al (1990) Comorbidity of mental disorders with alcohol and other drug abuse: results from the Epidemiologic Catchment Area (ECA) Study. JAMA 264:2511–2518
44. Weaver T, Madden P, Charles V, Stimson G, Renton A, Tyrer P, Barnes T, Bench C, Middleton H, Wright N, Paterson S, Shanahan W, Seivewright N, Ford C; on behalf of the Comorbidity of Substance Misuse and Mental Illness Collaborative (COSMIC) Study Team (2003) Comorbidity of substance misuse and mental illness in community mental health and substance misuse services. Br J Psychiatry 183:304–313
45. Krausz M (1996) Old problems – new perspectives. Eur Addict Res 2:1–2
46. Lehmann AF, Meyers CP, Corty E (1989) Classification of patients with psychiatric and substance abuse syndromes. Hosp Community Psychiatry 40:1019–1025
47. Ingram A, Johnson G, Heyes I (1997) Self harm and suicide by detained persons: a study. Police Research Group Publications, Home Office, London
48. Norfolk GA (1998) Deaths in police custody during 1994: a retrospective analysis. J Clin Forensic Med 5:49–54
49. The National Institute for Clinical Excellence (NICE) (2004) Self harm. The short-term physical and psychological management and secondary prevention of self-harm in primary and secondary care. CG16 Quick reference guide. www.nice.org.uk. Accessed July 2004
50. Schnieden V, Stark MM, Payne-James JJ (1995) Violence in clinical forensic medicine. Med Sci Law 35:333–335

51. Schnieden V, Maguire J (1993) A report on violence at work and its impact on the medical profession within hospitals and the community. British Medical Association, London
52. Royal College of Psychiatrists (1997) Using the Mental Health Act – a training resource for doctors. Gaskell, Royal College of Psychiatrists, Lomdon, p 72
53. Johns A, Clarke S, Stark MM (1997) Management of potentially violent detainees. J Clin Forensic Med 1:139–144
54. Traub SJ, Kohn GL, Hoffman RS, Nelson LS (2003) Pediatric 'body packing'. Arch Pediatr Adolesc Med 157(2):174–177
55. British Medical Association and the Faculty of Forensic and Legal Medicine (2010) Recommendations for healthcare professionals asked to perform intimate body searches. www.fflm.ac.uk. Accessed July 2010
56. Stark MM (1997) Guidelines for police surgeons asked to perform intimate searches for drugs. Education and Research Sub-Committee of the Association of Police Surgeons, Harrogate
57. Heinemann A, Miyaishi S, Iwersen S, Schmoldt A, Puschel K (1998) Body-packing as cause of unexpected sudden death. Forensic Sci Int 92:1–10
58. Koehler S, Ladham S, Rozin L, Shakir A, Omalu B, Dominick J, Wecht C (2005) The risk of body packing: as case of a fatal cocaine overdose. Forensic Sci Int 151:81–84
59. Glass JM, Scott HJ (1995) "Surgical mules": the smuggling of drugs in the gastrointestinal tract. J R Soc Med 88:450–453
60. Das D, Ali B (2003) Conservative management of asymptomatic cocaine body packers. Emerg Med J 20(2):172–174
61. F v West Berkshire Health Authority 2 All ER 545, 1989
62. Norfolk GA (2007) The fatal case of a cocaine body-stuffer and a literature review – towards evidence based management. J Forensic Leg Med 14:49–52
63. Bucke T, Teers R, Payne-James JJ, Stark MM (2008) Near misses in police custody: a collaborative study with forensic medical examiners in London. IPCC Research and Statistics Series: Paper 10. IPCC. www.ipcc.gov.uk. Accessed March 2008
64. Reddy RG, Aung T, Karavitaki N, Wass JAH (2010) Opioid induced hypogonadism. BMJ 341:c4462
65. Evans V (2010) Recommendations: Medical care of persons detained under the Terrorism Act 2000. FFLM. www.fflm.ac.uk
66. The Istanbul statement on the use and effects of solitary confinement. Adopted on 9 Dec 2007 at the International Psychological Trauma Symposium, Istanbul. http://www.solitaryconfinement.org/uploads/Istanbul_expert_statement_on_sc.pdf
67. Shalev S (2008) A sourcebook on solitary confinement http://solitaryconfinement.org/Sourcebook
68. Centers for Disease Control and Prevention (2010) Developmental disabilities. Intellectual disabilities. http://www.cdc.gov/ncbddd/dd/ddmr.htm. Accessed 23 Oct 2010
69. Folstein MF, Folstein SE, McHugh PR (1975) "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiat Res 12:189–198

Chapter 10
Infectious Diseases: The Role of the Forensic Physician

Felicity Nicholson

Introduction

Infections have plagued doctors for centuries, both in the diagnosis of the specific diseases, and the identification and subsequent management of the causative agents. There is a constant need for information as new organisms emerge, existing ones develop resistance to current drugs or vaccines and there are changes in epidemiology and prevalence. In the twenty-first century, obtaining this information has never been more important. Population migration, and the relatively low cost of flying, means that unfamiliar infectious diseases may be brought into industrialised countries. An example of this was an outbreak of severe acute respiratory syndrome (SARS), which was first recognised in 2003. Despite modern technology and a huge input of money, it took months for the agent to be identified, a diagnostic test to be produced, and a strategy for disease reporting and isolation to be established.

A further example of how population migration can result in the spreading of disease was with the appearance of swine influenza A (H1N1). In March 2009, the first case was reported in Mexico; by June 2009, over 22,000 cases had been reported in 70 countries, thus fulfilling the criteria for a pandemic. Challenges ensued with decisions about treatment and then the distribution and administration of specific vaccine.

There is no doubt that other new and fascinating diseases will continue to emerge. For the forensic physician dealing with infections presents two main problems. First, managing detainees or police personnel who have contracted a disease and may be infectious or unwell, and second, handling complainants of assault,

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including police officers, who have potentially been exposed to an infectious disease. The latter can be distressing for those involved, compounded in part from an inconsistency of management guidelines, if indeed they exist.

With the advent of human rights legislation, increasing pressure is being placed on doctors with regard to consent and confidentiality of the detainee. Therefore, it is prudent to pre-empt such situations before the consultation begins by obtaining either written or verbal consent from the detainee to allow certain pieces of information to be disclosed. If they do not agree, then the doctor must decide whether withholding relevant details will endanger the lives or health of those working within custody or others with whom they may have had close contact (whether or not deliberate). Issues of consent and confidentiality are discussed in detail in Chap. 2.

Adopting a universal approach with all detainees will decrease the risk to staff of acquiring such diseases and will help to stop unnecessary overreaction and unjustified disclosure of sensitive information. For victims of violent or sexual assault, a more open-minded approach is needed (see also Chap. 3). If the assailant is known, then it may be possible to make an informed assessment of the risk of certain diseases by ascertaining their lifestyle. If, however, the assailant is unknown, then it is wise to assume the worst. This chapter aims to highlight the most common infections encountered by the forensic physician. It aims to dispel "urban myths" and provide a sensible approach for achieving effective management.

Universal Precautions

The risk of exposure to infections, in particular to blood-borne viruses (BBVs), can be minimised by adopting measures that are considered good practice in the UK, the USA and Australia [1–3].

Forensic physicians or other healthcare professionals should wash their hands before and after contact with each detainee or victim. Police officers should be encouraged to wash their hands after exposure to body fluids or excreta. All staff should wear gloves when exposure to body fluids, mucous membranes or non-intact skin is likely. Gloves should also be worn when cleaning up body fluids or handling clinical waste including contaminated laundry. Single-use gloves should only be used and must conform to the requirements of European Standard 455 or equivalent [1–3]. A synthetic alternative conforming to the same standards should also be available for those allergic to latex.

All staff should cover any fresh wounds (less than 24 h old), open skin lesions or breaks in exposed skin with a waterproof dressing. Gloves cannot prevent percutaneous injury, but may reduce the chance of acquiring a blood-borne viral infection by limiting the volume of blood inoculated. Gloves should only be worn when taking blood, providing this does not reduce manual dexterity and therefore increase the risk of accidental percutaneous injury.

Ideally, a designated person should be allocated to ensure the clinical room is kept clean and sharps containers and clinical waste bags should be removed on a regular basis. Clinical waste must be disposed of in "hazard bags" and should never be over-filled. After use they should be double-bagged and sealed with "hazard tape". The bags should be placed in a designated waste disposal (preferably outside the building) and removed by a professional company.

When cells are contaminated with body fluids, a professional cleaning company should be called to attend as soon as possible. Until such time, the cell should be deemed "out of action".

Sharps Awareness

There is a legal requirement in the UK under the Environmental Protection Act (1990) and the Control of Substances Hazardous to Health Regulations 1994 (COSHH) to dispose of sharps in an approved container. In the USA, the Division of Healthcare Quality Promotion (DHQP) on the Centers for Disease Control and Prevention (CDC) website provides similar guidance. In custody where sharps containers are transported off site, they must be of an approved type. In the UK, such a requirement is contained within the Carriage of Dangerous Goods (Classification, Packaging and Labelling) and Use of Transportable Pressure Receptacles Regulations 1996. These measures help to minimise the risk of accidental injury. Further precautions include wearing gloves when handling sharps and never bending, breaking or re-sheathing needles before disposal. Sharps bins should never be over-filled, left on the floor or placed above the eye level of the smallest member of staff.

Contaminated Bedding

Any bedding that is visibly stained with body fluids should be handled with gloves. There are only three acceptable ways of dealing with contaminated bedding:

1. Laundering with a detergent at a minimum temperature of 71°C (160°F) or at a lower temperature (22–50°C) with water containing detergent and 50–150 ppm of chlorine bleach.
2. Dry cleaning at elevated temperatures/dry cleaning cold followed by steam pressing.
3. Incineration.

It is not considered acceptable practice to share bedding between detainees.

Other Measures

It is not necessary for staff to wear masks or protective eyewear in the custodial setting as the risk of infection is low. However, single use eyewash should be available in the clinical room or contained in other first aid kits located within the police station in case of accidental exposure. Contact lenses should be removed prior to eye washing.

Formulation of Guidelines

An example of good practice is contained within the UK Health Department's 1998 document [1] which states "that it is the responsibility of Health Authorities, Health Boards and NHS Trusts to create their own local guidelines to prevent the spread of BBVs in the health care setting". Such guidelines may not exist in other work places. If this is the case, then they should be formulated as soon as possible. Forensic physicians working for the Royal Military Police in the UK can refer to the "Good Practice Guidelines" [4]. It is also prudent to pre-arrange a system of referral with the nearest hospital that has an Accident and Emergency Department, a Genito-Urinary Department and access to a Specialist. The latter may be a consultant in Virology, Microbiology, Infectious Diseases or Genito-Urinary Medicine. Similar guidance in the USA can be found in "The Guideline for Infection Control in Health Care Personnel" [5].

Most exposures to staff usually result from a failure to follow accepted practice; however, accidents can happen no matter how much care is taken. All forensic physicians and other healthcare professionals working in custody should understand what constitutes a risk. This involves taking a detailed history of the incident, including the type of exposure, the body fluids involved and when it occurred.

This information could help to allay unnecessary anxiety from the outset and will ensure that the recipient of the exposure is referred, if appropriate, to the designated hospital at the earliest opportunity. Knowledge of precise treatment protocols is not required, but it is helpful to be able to explain to the recipient what to expect. For example, he or she will be asked to provide a voluntary baseline blood sample for storage and a number of follow-up samples for testing depending on the nature of the exposure. This is especially relevant for hepatitis B (HBV), hepatitis C (HCV) and human immunodeficiency virus (HIV). Most usually, this will be complete by 12 weeks, but on rare occasions testing may be extended to 6 months after the incident.

Sexual assault victims should ideally be referred to specialist centres, if available. A police station should only be used as a last resort because the environment is often hostile and there is no ready access to the necessary treatment and ongoing management (see Chap. 3).

Routes of Transmission

Organisms may utilise more than one route. For ease of understanding, the infections discussed in this chapter are classified according to their primary route, i.e. transmission through blood and body fluids; through contact with lesions or organisms; through the respiratory route; and through the faecal-oral route.

Transmission Through Blood and Body Fluids

The BBVs which present most cross-infection hazard to staff or victims are those associated with persistent viral replication and viraemia. These include hepatitis B (HBV), hepatitis C (HCV), hepatitis D (HDV) and human immunodeficiency virus (HIV).

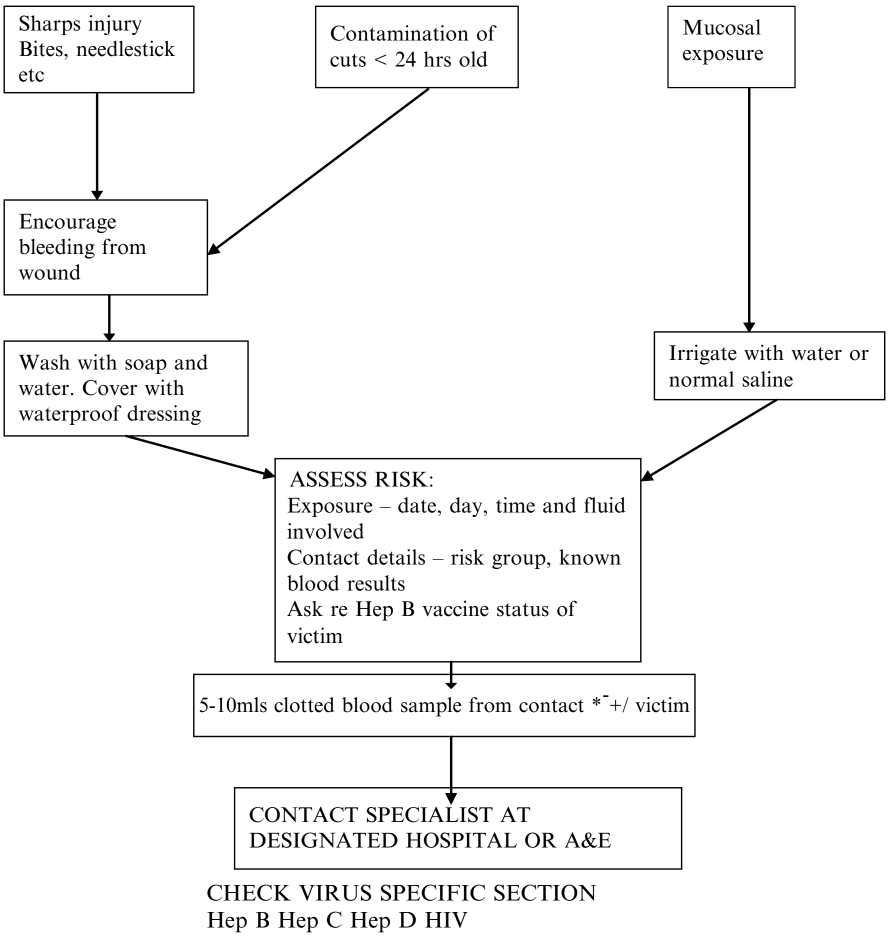
In general, risks of transmission of BBVs arise from the possible exposure to blood or other body fluids. The degree of risk varies with the virus concerned and will be discussed under the relevant sections. Figure 10.1 illustrates the immediate management following a percutaneous injury, mucocutaneous exposure, or exposure through contamination of fresh cuts or breaks in the skin.

Hepatitis B

Epidemiology and Prevalence

HBV is endemic throughout the world with populations showing a varying degree of prevalence. Approximately 2,000 million people have been infected with HBV, with more than 350 million having chronic infection. Worldwide HBV kills about 1 million people each year. With the development of a safe and effective vaccine in 1982, the World Health Organisation (WHO) recommended that HBV vaccine should be incorporated into national immunisation programmes by 1995 in those countries with a chronic infection rate of 8% or higher and into all countries by 1997. Although 135 countries had achieved this goal by the end of 2001, the poorest countries – often with the highest prevalence – have been unable to afford it. In particular, these include China, the Indian Sub-continent and Sub-Saharan Africa.

People in the early stages of infection or with chronic carrier status (defined by persistence of hepatitis B surface antigen [HBsAg] beyond 6 months) can transmit infection. In the United Kingdom, the overall prevalence of chronic HBV is around 0.2–0.3% [6, 7]. A detailed breakdown is shown in Table 10.1.



*In the UK written consent from the contact must be sent with the sample countersigned by the healthcare practitioner and an independent police officer should also sign.

Fig. 10.1 Immediate management following occupational exposure to blood-borne viruses (BBVs)

Table 10.1 Prevalence of chronic hepatitis B (HBV)

Blood-doning population – <1%
Intravenous drug users – 10–15%
Homosexual/bisexuals – 10–15%
Institutionalised patients – no data available
People from high-risk endemic areas, e.g. China and the Far East, up to 30% of the population are carriers and 75% have evidence of past infection. In Africa, 5–10% are carriers

Table 10.2 Significance of markers

Name	Infectivity	Immunity	Risk following needle stick (%)
HBsAg	Yes	No	Only marker = 10–20
HBeAg	Yes	No	With HBsAg = 30–40
HBeA	Yes	Yes	With HBsAg = <10
HBCA	No	Yes	0
HBSA	No	Yes	0

HBsAg Hepatitis B surface antigen; *HbeAg* hepatitis B e antigen; *HBeA* hepatitis B e antibody; *HBCA* hepatitis B core antibody; *HBSA* hepatitis B surface antibody

Symptoms and Complications

The incubation period is approximately 6 weeks to 6 months. As the name suggests, the virus primarily affects the liver. Typical symptoms include malaise, anorexia, nausea, mild fever, and abdominal discomfort and may last from 2 days to 3 weeks before the insidious onset of jaundice. Joint pain and skin rashes may also occur due to immune complex formation. Infections in the newborn are usually asymptomatic.

The majority of patients with acute HBV make a full recovery and develop immunity. Following acute infection, about 1 in 300 patients develop liver failure, which may result in death.

Chronic infection develops in around 90% of neonates, about 50% of children and between 5 and 10% of adults. Neonates and children are usually asymptomatic. Adults may have only mild symptoms or may also be asymptomatic. Approximately 15–25% of chronically infected individuals (depending on age of acquisition) will develop cirrhosis over a number of years. This may also result in liver failure or other serious complications including hepatocellular carcinoma, though the latter is rare. The overall mortality rate of HBV is estimated at less than 5%.

Period of Infectivity

A person is deemed infectious if HBsAg is detected in the blood. In the acute phase of the illness, this can be as long as 6 months. By definition, if HBsAg persists for after this time then the person is deemed a carrier. Carriers are usually infectious for life. The degree of infectivity depends on the stage of disease and the markers present in Table 10.2.

Routes of Transmission

The major routes include: parenteral (e.g. needlestick injuries, bites, unscreened blood transfusions, tattooing, acupuncture and dental procedures, where equipment is inadequately sterilised); mucous membrane exposure (including mouth, eyes and genital mucous membranes) and contamination of broken skin (especially when <24 h old).

At-Risk Groups

HBV is an occupational hazard for anyone who may come into contact with blood or bloodstained body fluids through the routes described above. Saliva alone may transmit HBV. The saliva of some people infected with HBV has been shown to contain HBV-DNA concentrations 1/1,000–1/10,000 of that found in their serum [8]. This is especially relevant for penetrating bite wounds. Infection following exposure to other body fluids, e.g. bile, urine, faeces and CSF, has never been demonstrated unless the fluids are contaminated with blood.

Intravenous drug users who share needles or other equipment are also at risk. HBV can also be transmitted through unprotected sexual contact, whether homosexual or heterosexual. The risk is increased if blood is involved. Victims of sexual assault should be included in this category.

Evidence has shown that the virus may also be spread among members of a family through close household contact. This is thought to be through kissing, sharing toothbrushes, razors, bath towels, etc. [9–11]. This route of transmission probably applies to institutionalised patients, but there is no available data.

Studies of prisoners in western countries have shown a higher prevalence of antibodies to HBV and other BBVs than the general population [12–14]; the most commonly reported risk factor being intravenous drug use. However, the real frequency of transmission of BBVs in British prisons is unknown due to the difficulty in compiling reliable data.

HBV can be transmitted vertically from mother to baby during the perinatal period. Around 80% of babies born to mothers who have either acute or chronic HBV become infected and most will develop chronic HBV. This has been limited by the administration of HBV vaccine to the neonate. In industrialised countries all antenatal mothers are screened for HBV. Vaccine is given to the neonate ideally within the first 12 h of birth and at least two further doses are given at designated intervals. The WHO recommends this as a matter of course for all women in countries where prevalence is high. However, the practicalities of administering vaccine that has to be stored at the correct temperature and limited access to medical care mean that there is a significant failure of vaccine uptake and response.

Disease Prevention

In industrialised countries, HBV vaccination is recommended for those deemed at risk of acquiring the disease

1. Through occupational exposure
2. Homosexual/bisexual men
3. Intravenous drug users

4. Sexual partners of people with acute or chronic HBV
5. Family members of people with acute or chronic HBV
6. Newborn babies whose mothers are infected with HBV. If the mother is HBeAg positive, then HBV-specific immunoglobulin (HBSIG) should be given at the same time as the first dose of vaccine
7. Institutionalised patients and prisoners

Ideally, HBV vaccine should be administered prior to exposure. The routine schedule (RS) consists of three doses of vaccine given at 0, 1 and 6 months. Antibody levels should be checked at 4–16 weeks after the last dose. If titres are greater than 10 miU/ml, then an adequate response has been achieved. In the UK, this is considered to provide protection for 5–10 years when one further dose would be given. In the USA, if an initial adequate response has been achieved, then no further doses of vaccine are considered necessary.

Vaccine administration after exposure varies according to the timing of the incident, the degree of risk involved, and whether the individual has already been partly or fully vaccinated. An accelerated schedule (AS) when the third dose is given 2 months after the first dose with a booster a year later is used to prevent perinatal transmission. Where risks are greatest then it may be necessary to use a rapid schedule (RDS). The doses are given at 0, 7, 21–28 days after presentation, again with a booster dose at 6–12 months. This schedule is currently only licenced with Engerix B.

HBIG may also be used either alone or in conjunction with vaccine. The exact dose given is age-dependent, but must be administered by deep intra-muscular injection in a different site from the vaccine. In an adult, this is usually into the gluteus muscle.

HBIG is given in conjunction with the first dose of vaccine to individuals deemed at high risk of acquiring disease and the incident occurred within 72 h of presentation. It is also used for neonates born to mothers who are HBeAg-positive.

Between 5 and 10% of adults fail to respond to the routine schedule of vaccine. A further full course of vaccine should be tried before deeming them "non-responders". Such individuals involved in a high-risk exposure should be given two doses of HBIG administered a month apart. Ideally, the first dose should be given within 48 h after exposure and no longer than 2 weeks after exposure.

Other measures include minimising the risk of exposure by adopting the safe working practices outlined in section "Universal Precautions". Any potential exposures should be dealt with as soon as possible. In industrialised countries, blood, blood products and organs are routinely screened for HBV.

Intravenous drug users should be encouraged to be vaccinated and to avoid sharing needles or any other drug paraphernalia (see "Management in Custody" in section "Other Bacteria Associated with Abscess Formation in Injecting Drug Users").

Management in Custody

For staff or victims in contact with disease, it is wise to have a procedure in place for immediate management and risk evaluation. An example is shown in Fig. 10.1.

While forensic physicians are not expected to administer treatment, it is often helpful to inform persons concerned what to expect. Tables 10.3 and 10.4 outline treatment protocols as used in the United Kingdom.

Detainees with disease can usually be managed in custody. If the detainee is bleeding, then the cell should be deemed out of action after they have left until it can be professionally cleaned. Contaminated bedding should be dealt with as described in section "Contaminated Bedding". If the detainee has chronic HBV and is on an antiviral agent (e.g. Lamivudine), then the treatment course should be continued, if possible.

Hepatitis C

Epidemiology and Prevalence

HCV is endemic in most parts of the world. Approximately 3% (200 million) of the world's population are infected with HCV [15]. For many countries, no reliable prevalence data exist.

Seroprevalence studies carried out among blood donors have shown that the highest prevalence exists in Egypt (17–26%). This has been ascribed to contaminated needles used in the treatment of schistosomiasis carried out between the 1950s and the 1980s [16].

Intermediate prevalence (1–5%) exists in Eastern Europe, the Mediterranean, the Middle East, the Indian Sub-continent and parts of Africa and Asia. In Western Europe, most of Central America, Australia and limited regions in Africa including South Africa, the prevalence is low (0.2–0.5%). Previously, America was included in the low prevalence group, but a report published in 2003 [17] indicated that almost 4 million Americans, i.e. 1.8% of the population, have antibody to HCV, representing either ongoing or previous infection. It also states that HCV accounts for approximately 15% of acute viral hepatitis in America.

The lowest prevalence (0.01–0.1%) has been found in the UK and Scandinavia. However, within any country, there are certain groups that have a higher chance of carrying HCV. In the UK, these are given in Table 10.5.

Symptoms and Complications

After an incubation period of 6–8 weeks, the acute phase of the disease lasts approximately 2–3 years. Unlike hepatitis A (HAV) or HBV, the patient is usually asymptomatic; therefore, the disease is often missed unless the individual has reported a specific exposure and is being monitored. Other cases are found by chance, when raised liver enzymes are found on a routine blood test.

A "silent phase" follows the acute phase when the virus lies dormant and the liver enzymes are usually normal. This period lasts approximately 10–15 years.

Table 10.3 Management following high-risk exposure

Vaccination status	Hepatitis B-specific immunoglobulin (HBSIG)	Hepatitis B vaccine	Follow up	Notes
Not vaccinated	Yes if <3 days after exposure	Yes	AS via GP	
	No if >3 days	Yes	Rapid schedule (RDS) via GP	Advise GP of timing
Vaccinated: non-responder	Yes if within 3 days	No	Repeat HBSIG at 1 month	Consider trying newer vaccines at later stage
Course completed. Levels >10 miU/ml	No	Yes if primary course >3 years ago	No	
Course completed within 3 years. Levels not checked	No	Yes	GP to check results of baseline blood test	If baseline antibodies <10 miU/ml advise RDS
If >3 years see below				
Incomplete course (one or two doses)	Yes if within 3 days	Yes	GP to check results of baseline blood test	>10 miU/ml – RS
	No if >3 days	Yes		<10 miU/ml – RDS

Contact in high-risk group or HBsAg positive and person has had a high-risk exposure

Table 10.4 Management following low-risk exposure

Vaccination status	HBSIG	Vaccine	Follow up	Notes
Not vaccinated	No	Yes	RS via GP	
Vaccinated non-responder	No	No		Consider using newer vaccines
Course completed	No	Yes if not checked or >3 years since 1° course		
Incomplete course	No	Yes	GP to check results of baseline test	<10 miU/ml complete RS

Contact is in low-risk group or known to be HBsAg negative and person has had a low-risk exposure

Table 10.5 Prevalence of hepatitis C (HCV)

General blood-doning population	0.06%
Organ donors	0.72%
Haemophiliacs	100%[a]
Intravenous drug users	28–57%
Homosexual/bisexuals	<5%

[a]Statistics apply to all who received blood products before the mid-1980s

Reactivation may then occur. Subsequent viral replication damages the hepatocytes, and liver enzymes rise to moderate or high levels.

Eighty percent of individuals who are HCV antibody-positive are infectious, regardless of the levels of their liver enzymes. Approximately 80% of people develop chronic infection, one fifth of whom progress to cirrhosis. There is a much stronger association with hepatocellular carcinoma than with HBV. An estimated 1.25–2.5% of patients with HCV-related cirrhosis develop liver cancer [18]. Less than 2% of chronic cases resolve spontaneously.

Routes of Transmission

Approximately 75% of cases are parenteral (e.g. needlestick, etc.) [19]. Transmission through the sexual route is not common and only appears to be significant if there is repeated exposure with one or more people infected with HCV. Mother-to-baby transmission is considered to be uncommon, but has been reported [20]. Theoretically, household spread is also possible through sharing contaminated toothbrushes or razors.

Since the disease is often silent, there is a need to raise awareness among the general population on how to avoid infection and to encourage high-risk groups to be tested. Healthcare professionals should also be educated to avoid occupationally acquired infection. An example of good practice is contained within the document 'Hepatitis C strategy for England', issued by the Department of Health in 2002 [18].

Risks from Exposure from HCV RNA-Positive Person

Blood or bloodstained body fluids need to be involved for a risk to occur. Saliva alone is not deemed to be a risk. The risk from a single needlestick incident is 1.8% (range 0–7%). Contact through a contaminated cut is estimated at 1%. For penetrating bite injuries, there is no data, but it is only considered a risk if blood is involved. Blood or bloodstained body fluids have to be involved in transmission through mucous membrane exposure. This may account for the lower than expected prevalence among the gay population.

Management in Custody

Staff/Victims in Contact with Disease

Follow the immediate management flow chart, making sure all available information is obtained. Inform the designated hospital and/or specialist as soon as possible. If the contact is known and is thought to be immunocompromised, and he or she has consented to provide a blood sample, it is important to tell the specialist, as their antibody tests may be spuriously negative. In this instance, a different test should be used (polymerase chain reaction [PCR] which detects viral RNA).

The staff member/victim will be asked to provide a baseline sample of blood with further samples at 4–6 weeks and again at 12 weeks. If tests are negative at 12 weeks, but the risk was deemed high, then follow-up may continue for up to 24 weeks. If any of the follow-up samples are positive, then the original baseline sample will be tested to ascertain whether the infection was acquired through the particular exposure.

Chronic HCV may be treatable with a combination of pegylated or non-pegylated interferons and ribavirin. Treatment success depends upon many factors including disease stage and viral genotype [21, 22]. Treatment in the early stages of infection is nearly always successful regardless of the genotype, so early detection is important.

Detainees with disease: Unless they are severely ill, detainees can be managed in custody. Special precautions are only required if they are bleeding. Custody staff should wear gloves if contact with blood is likely. Contaminated bedding should be handled appropriately and the cell cleaned professionally after use.

Hepatitis D (Delta Agent)

This defective transmissible virus discovered in 1977 requires HBV for its own replication. It has a worldwide distribution in association with HBV with approximately 15 million people infected. The prevalence of HDV is higher in southern Italy, the Middle East, and parts of Africa and South America occurring in greater than 20% of asymptomatic HBV carriers and greater than 60% of those with chronic HBV-related liver disease. Despite the high prevalence of HBV in China and South East Asia, HDV in these countries is rare.

HDV is associated with acute (co-infection) and chronic hepatitis (superinfection) and can exacerbate pre-existing liver damage caused by HBV. The routes of transmission and at-risk groups are the same as for HBV. Staff/victims in contact with a putative exposure and detainees with disease should be managed as for HBV. Interferon-alpha (e.g. Roferon) can be used to treat patients with chronic HBV and HDV [23], though it would not be practical to continue this treatment in the custodial setting.

Human Immunodeficiency Virus

Epidemiology and Prevalence

HIV was first identified in 1983 – 2 years after the first reports were made to the CDC Atlanta, GA, of an increased incidence of two unusual diseases (Kaposi's sarcoma and *Pneumocystis carinii* pneumonia) occurring among the gay population in San Francisco. The scale of the virus gradually emerged over the years, and by the end of 2002, there was an estimated 42 million people throughout the world living with HIV or AIDS. Over 80% of the world total live in Africa and India. A report by UNAIDS and the WHO in 2002 stated that one in five adults in Lesotho, Malawi, Mozambique, Swaziland, Zambia and Zimbabwe has HIV or AIDS. There is also expected to be a sharp rise in cases of HIV in China, Papua New Guinea and other countries in Asia and the Pacific over the next few years.

In the UK by the end of 2002, the cumulative data reported that there were 54,261 individuals with HIV, AIDS (including deaths from AIDS) reported, though this is likely to be an underestimate [24]. By the end of 2006, the HIV prevalence increased to 78,000 with one-third being undiagnosed. The group still considered at greatest risk of acquiring HIV in the United Kingdom is men who have sex with men (MSM) with 5.4% of those aged 15–44 being infected [25].

Among intravenous drug users, the overall estimated prevalence is 1 in 73, but in London the figure is higher at 1 in 20 [25]. In the 1980s, up to 90% of users in Edinburgh and Dundee were reported to be HIV positive, but the majority have now died.

In 2006, 78,000 new diagnoses were made and nearly half of these were in black Africans. Each year, more HIV infections are being acquired heterosexually within the UK [25].

The incidence of mother-to-baby transmission has been estimated at 15% in Europe, and around 45% in Africa. The transmission rates among African women are thought to be much higher due to a combination of more women with end-stage disease with a higher viral load and concomitant placental infection, which renders it more permeable to the virus [26, 27]. The use of anti-retroviral therapy during pregnancy together with the advice to avoid breastfeeding has proved efficacious in reducing both vertical and horizontal transmission among HIV positive women in the western world. For those in third world countries, the reality is stark. Access to treatment is limited and there is no realistic substitute for breast milk, which provides a valuable source of antibodies to other life-threatening infections. Patients receiving blood transfusions, organs or blood products where screening is not routinely carried out must also be included.

Incubation Period and Phases of Infection

The incubation is estimated at 2 weeks to 6 months after exposure. This is dependent to some extent on the ability of current laboratory tests to detect HIV antibodies or viral antigen. The majority of cases are now diagnosed within 12 weeks. The development of PCR for viral RNA has improved sensitivity.

During the acute phase of the infection, about 50% experience a seroconversion "flu-like" illness. The individual is infectious at this time, as viral antigen (p24) is present in the blood. As antibodies start to form, the viral antigen disappears and the individual enters the latent phase. They are non-infectious and remain well for a variable period of time (7–15 years). Development of the AIDS marks the terminal phase of disease. Viral antigen re-emerges and the individual is once again infectious. The onset of AIDS has been considerably delayed with the use of anti-retroviral treatment.

Routes of Transmission

Parenteral transmission includes needle stick injuries, bites, unscreened blood transfusions, tattooing, acupuncture and dental procedures where equipment is inadequately sterilised. Risk of transmission is increased with deep penetrating injuries with hollow bore needles that are visibly bloodstained, especially when the device has previously been in the source patient's (contact) artery or vein. Other routes include mucous membrane exposure, (eyes, mouth and genital mucous membranes) and contamination of broken skin.

The higher the viral load in the contact, the greater the risk of transmission. This is more likely at the terminal stage of infection. HIV is transmitted mainly through blood or other body fluids that are visibly bloodstained with the exception of semen, vaginal fluid and breast milk. Saliva alone is most unlikely to transmit infection. Therefore, people who have sustained penetrating bite injuries can be reassured that they are not at risk providing the contact was not bleeding from the mouth at the time.

Risk of Seroconversion

The risk from a single percutaneous exposure from a hollow bore needle is low and a single mucocutaneous exposure is even less likely to result in infection.

The risk from sexual exposure varies, though it appears that there is a greater risk with receptive anal intercourse compared with receptive vaginal intercourse [28].

Body Fluids Containing HIV

High-risk fluids include blood, semen, vaginal fluid and breast milk. There is little or no risk from saliva, urine, vomit or faeces unless they are visibly bloodstained. Other fluids that constitute a theoretical risk include CSF, peritoneal, pleural, synovial or pericardial fluid.

Management in Custody of Staff/Victims in Contact with Disease

Management in custody of staff/victims in contact with disease includes following the immediate management flow chart (Fig. 10.1) and contacting the designated hospital/specialist with details of the exposure. Where possible, obtain a blood sample from the contact. Like HBV and HCV, blood samples taken for HIV testing can only be taken with informed consent in the United Kingdom. There is no need for the forensic physician to go into details about the meaning of the test, but the contact should be encouraged to attend the genito-urinary department (or similar) of the designated hospital to discuss the test results. Should the contact refuse to provide a blood sample, then any information about their lifestyle, ethnic origin, state of health, etc. may be useful for the specialist to decide whether post-exposure prophylaxis (PEP) should be given to the recipient. Where saliva only is involved in a penetrating bite injury, there is every justification to reassure the recipient that there is little risk of acquiring HIV. However, it is still wise to take advice from a specialist.

In the United Kingdom, the current recommended regime for PEP is one Truvada tablet (254 mg tenofovir and 200 mg emtricitabane (FTC)) once a day plus two Kaletra film-coated tablets (200 mg lopinavir and 50 mg of ritonavir) twice a day [29].

It is only given following a significant exposure to a high-risk fluid or any that is visibly bloodstained and the contact is known or is highly likely to be HIV positive. Ideally, treatment should be started within an hour after exposure, and certainly within 72 h. Extenuating circumstances beyond the remit of this chapter may allow for PEP to be given after a longer period following exposure [29]. It is usually given for 4 weeks unless the contact is subsequently identified as HIV negative or the recipient develops tolerance or toxicity occurs. Weekly follow-up of the recipient should take place during treatment to improve adherence, monitor drug toxicity and deal with other concerns.

Other useful information that may influence the decision whether to treat with the standard regime or use alternative drugs include interaction with other medications that the recipient may be taking or if the contact has been on anti-retroviral therapy or if the recipient is pregnant. No data exist as to the efficacy of PEP beyond occupational exposure [30].

PEP is not considered for exposure to low or no risk fluids through any route, nor where the source is unknown, e.g. a discarded needle. Despite the appropriate use and timing of PEP, there have been reports of failure [31, 32].

Management in Custody of Detainees with HIV

Unless they are severely ill, they can be kept in custody. Every effort should be made to continue any treatment they may be receiving. Apply universal precautions when dealing with the detainee and ensure that contaminated cells and/or bedding are managed appropriately.

Transmission Through Contact with Lesions or Organisms

Varicella (Chicken Pox)

Epidemiology and Prevalence

Cases of this highly infectious disease occur throughout the year, but are more frequent in winter and early spring. This seasonal endemicity appears to be blurring with global warming. In the UK, the highest prevalence occurs in the 4–10 years age group. Ninety percent of the population over the age of 40 are immune [33]. A similar prevalence has been reported in other parts of Western Europe and the USA. In South East Asia, Varicella is mainly a disease of adulthood [34]. Therefore, people born in these countries who have moved to the UK are more likely to be susceptible to chicken pox.

There is a strong correlation between a history of chicken pox and serologic immunity (97–99%). Most adults born and living in industrialised countries with an uncertain or negative history of chicken pox are also seropositive (70–90%). In March 1995, a live-attenuated vaccine was licenced for use in the USA and a policy for vaccinating children and susceptible healthcare personnel was introduced. In the summer of 2002 in the UK, GlaxoSmithKline launched a live-attenuated vaccine called Varilrix. In December 2003, the Department of Health, following advice from the Joint Committee on Vaccination and Immunisation (JCVI), recommended that the vaccine be given for non-immune healthcare workers who are likely to have direct contact with individuals with chicken pox. Any healthcare worker with no previous history of chicken pox should be screened for immunity, and if no antibodies are found, they should receive two doses of vaccine 4–8 weeks apart. The vaccine is not currently recommended for children and should not be given during pregnancy.

Incubation Period and Symptoms

Following an incubation period of 10–21 days (this may be shorter in the immunocompromised), there is usually a prodromal “flu-like” illness before the onset of the rash. This coryzal phase is more likely in adults. The lesions typically appear in crops; rapidly progressing from red papules through vesicles to open sores that crust over and separate by 10 days. The distribution of the rash is centripetal, i.e. more over the trunk and face than on the limbs. This is the converse of small pox.

In adults, the disease is often more severe with lesions involving the scalp and mucous membranes of the oropharynx.

Complications

In children, the disease is often mild, unless they are immunocompromised, so are unlikely to experience complications. In adults (defined as 15 years or older), the picture is rather different [35]. Secondary bacterial infection is common, but rarely serious. There is an increased likelihood of permanent scarring. Haemorrhagic chickenpox typically occurs on the second or third day of the rash. Usually, this is limited to bleeding into the skin, but life-threatening melaena, epistaxis or haematuria can occur.

Varicella pneumonia ranges from patchy lung consolidation to overt pneumonitis and occurs in 1 in 400 cases [36]. It can occur in previously healthy individuals (particularly adults), but the risk is increased in those who smoke. Immunocompromised people are at the greatest risk of developing this complication. It runs a fulminating course and is the commonest cause of Varicella-associated death.

Fibrosis and permanent respiratory impairment may occur in those who survive. Any suspicion of lung involvement is an indication for immediate treatment and any detainee or staff member should be sent to hospital. Involvement of the CNS includes a variety of conditions including meningitis, Guillain–Barre and encephalitis. The latter is more common in the immunocompromised and can be fatal.

Period of Infectivity

This is taken as 3 days before the first lesions appear to the end of new vesicle formation and the last vesicle has crusted over. This typically is 5–7 days after onset, but may last up to 14 days.

Routes of Transmission

The primary route is through direct contact with open lesions of chicken pox. However, it is also spread through aerosol or droplets from the respiratory tract. Chicken pox may also be acquired through contact with open lesions of shingles (Varicella zoster), but this is less likely as shingles is less infectious than chicken pox.

At-Risk Groups

Non-immune individuals are at risk of acquiring disease. Approximately 10% of the adult population born in the UK and <5% of adults in the USA fall into this category. Therefore, it is more likely that if chicken pox is encountered in the custodial setting, it will involve people born outside the UK, (in particular South East Asia) or individuals who are immunocompromised and have lost immunity. Non-immune pregnant women are at risk of developing complications.

Pneumonia can occur in up to 10% of pregnant women with chicken pox and the severity appears to be increased in later gestation [37]. They can also transmit infection to the unborn baby [38]. If infection is acquired in the first 20 weeks, there is <3% chance of it leading to congenital Varicella syndrome. Infection in the last trimester can lead to neonatal Varicella unless more than 7 days elapse between onset of maternal rash and delivery when antibodies have time to cross the placenta leading to either mild or inapparent infection in the newborn. In this situation, Varicella immunoglobulin (VZIG) should be administered to the baby as soon as possible after birth [39].

Management in Custody

Staff with chicken pox should stay off work until the end of the infective period (approximately 7–14 days). Those in contact with disease who are known to be non-immune or who have no history of disease should contact the designated occupational health physician.

Detainees with disease should not be kept in custody if at all possible (especially pregnant women). If this is unavoidable, then non-immune or immunocompromised staff should avoid entering the cell or having close contact with the detainee.

Non-immune immunocompromised or pregnant individuals exposed to chickenpox should seek expert medical advice or the administration of VZIG. Aciclovir (or similar antiviral agent) should be given as soon as possible to immunocompromised people with chicken pox. It should also be considered for anyone over 15 years old as they are more likely to develop complications.

Anyone suspected of severe complications should be sent straight to hospital.

Herpes Zoster (Shingles)

Epidemiology

After chicken pox, the virus lies dormant in the dorsal root or cranial nerve ganglia, but may re-emerge and typically involves one dermatome [40]. The site of involvement depends on the sensory ganglion initially involved. Shingles is more common over the age of 50, except in the immunocompromised when attacks can occur at an earlier age. The latter are also more susceptible to secondary attacks and involvement of more than one dermatome. Bilateral zoster is even rarer, but is not associated with a higher mortality.

In the UK, there is an estimated incidence of 1.2–3.4 per 1,000-person years [41].

Symptoms

There may be a prodromal period of paraesthesia and burning or shooting pains in the involved segment. This is usually followed by the appearance of a band of vesicles. Rarely, the vesicles fail to appear and only pain is experienced. This is known as *zoster sine herpete*. In individuals who are immunocompromised, disease may be prolonged and dissemination may occur but is rarely fatal.

Shingles in pregnancy is usually mild. The foetus is only affected if viraemia occurs before maternal antibody has had time to cross the placenta.

Complications

The most common complication of shingles is post-herpetic neuralgia occurring in about 10% of cases. It is defined as pain lasting more than 120 days from rash onset [42]. It is more frequent in people over 50 and can lead to depression. It is rare in children including the immunocompromised. Infection of the brain includes encephalitis, involvement of motor neurones leading to ptosis, paralysis of the hand, facial palsy or contralateral hemiparesis. Involvement of the oculomotor division of the trigeminal ganglion can cause serious eye problems including corneal scarring.

Period of Infectivity

Shingles is far less infectious than chicken pox and is only considered to be infectious up to 3 days after lesions appear.

Routes of Transmission

Shingles is only infectious following prolonged contact with lesions. Unlike chickenpox, airborne transmission is not a risk.

At-Risk Groups

Individuals who are immunocompromised may reactivate the dormant virus and develop shingles. People who have not had primary Varicella are at risk of developing chicken pox following prolonged direct contact with shingles.

Despite popular belief, it is untrue that immunocompetent people who have had chicken pox develop shingles when in contact with either chicken pox or shingles. Such occurrences are merely coincidental unless immunity is lowered.

Management in Custody

Staff with shingles should stay off work until the lesions are healed unless they can be covered. Staff who have had chicken pox are immune (including pregnant women) and are therefore not at risk. If they are non-immune (usually accepted as those without a history of chickenpox), they should avoid prolonged contact with detainees with shingles. Pregnant non-immune women should avoid contact altogether.

Detainees with disease may be kept in custody and any exposed lesions should be covered. It is well documented that prompt treatment attenuates the severity of the disease, reduces the duration of viral shedding, hastens lesion healing, and reduces the severity and duration of pain. It also reduces the likelihood of developing post-herpetic neuralgia [43]. Prompt treatment with Famciclovir (500 mg tds for 7 days, for example) should be initiated if the onset is 3 days or less. It should also be considered after this time if the detainee is over 50. Pregnant detainees with shingles can be reassured that there is minimal risk for both the mother and the unborn child. Expert advice should be sort before initiating treatment for the mother.

Scabies

Epidemiology

This tiny parasitic mite (*Sarcoptes scabiei*) has infested humans for over 2,500 years. Experts estimate that in excess of 300 million cases occur worldwide each year. The female mite burrows into the skin especially around the hands, feet and male genitalia, in about 2.5 min. Eggs are laid and hatch into larvae that travel to the skin surface as newly developed mites.

Symptoms

The mite causes intense itching which is often worse at night and is aggravated by heat and moisture. The irritation spreads outside the original point of infection due to an allergic reaction to mite faeces. This irritation may persist for about 2 weeks after treatment, but can be alleviated by antihistamines.

Crusted scabies is a far more severe form of the disease. Large areas of the body may be involved. The crusts hide thousands of live mites and eggs making them difficult to treat. This so-called Norwegian scabies is more common in the elderly or the immunocompromised, especially those with HIV.

Incubation Period

Following a primary exposure, it takes about 2–6 weeks before the onset of itching. However, further exposures reduce the incubation time to around 1–4 days.

Period of Infectivity

Without treatment, this is assumed to be indefinite. With treatment, the person should be considered infectious until the mites and eggs are destroyed – usually 7–10 days. Crusted scabies is highly infectious.

Management in Custody

Since transmission is through direct skin-to-skin contact with an infected case, gloves should be worn when dealing with individuals suspected of infestation. Usually prolonged contact is needed, unless the person has crusted Scabies where transmission occurs more easily. The risk of transmission is much greater in households where repeated or prolonged contact is likely.

Since mites can survive in bedding of clothing for up to 24 h, gloves should also be worn when handling these items. Bedding should be treated using one of the methods above. Professional cleaning of the cell is only warranted in cases of crusted scabies.

Treatment

The preferred treatment for scabies is either permethrin cream (5%) or aqueous Malathion (0.5%) [44]. Either treatment has to be applied to the whole body and should be left on for at least 8 h in the case of permethrin and 24 h for Malathion before washing off. Lindane is no longer considered the treatment of choice, as there may be complications in pregnancy [45].

Treatment in custody may not be practical, but should be considered when the detainee is thought to have Norwegian scabies.

Head Lice

General Information

Like scabies, head lice occur worldwide and are found in the hair close to the scalp. The eggs or nits cling to the hair and are difficult to remove, but are not harmful. If you see nits then you can be sure that lice are also present. The latter are best seen when the hair is wet. The lice bite the scalp and suck blood causing intense irritation and itching.

Route of Transmission

They can only be passed from direct hair to hair contact.

Management in Custody

It is only necessary to wear gloves when examining the head for whatever reason. The cell does not need to be cleaned after use, since the lice live on or near skin. Bedding may be contaminated with shed skin so should be handled with gloves and laundered or incinerated.

The presence of live lice is an indication for treatment either by physical removal with a comb or the application of an insecticide. The latter may be more practical in custody. 0.5% aqueous Malathion should be applied to dry hair and washed off after 12 h. The hair should then be shampooed as normal.

Crabs or Body Lice

General Information

They are more commonly found in the pubic, axillary, chest and leg hair. However, eyelashes and eyebrows may also be involved. They are associated with people who do not bath or change clothes regularly. The person usually complains of intense itching or irritation.

Routes of Transmission

The main route is from person to person by direct contact, but eggs can stick to fibres so clothing and bedding should be handled with care (see section below).

Management in Custody

Staff should always wear gloves if they are likely to come into contact with any hirsute body part. Clothing or bedding should be handled with gloves and either laundered or incinerated.

Treatment of a detainee in custody is good in theory but probably impractical as the whole body has to be treated.

Fleas

General Information

Fleas lay eggs on floors, carpets and bedding. In the UK, most fleabites come from cats or dogs. The eggs and larvae fleas can survive for months and are reactivated in response to animal or human activity. Since animal fleas jump off humans after biting, most detainees with fleabites will not have fleas, unless they are human fleas.

Management in Custody

Treatment is only necessary if fleas are seen. After use, the cell should be vacuumed and cleaned with a proprietary insecticide. Any bedding should be removed wearing gloves, bagged and either laundered or incinerated.

Bedbugs

General Information

Bedbugs live and lay eggs on walls, floors, furniture and bedding. If you look carefully, faecal tracks may be seen on hard surfaces. If they are present for long enough, then they emit a distinct odour. Bedbugs are rarely found on the person, but may be brought in on clothing or other personal effects.

Symptoms

Bedbugs bite at night and can cause sleep disturbance.

Management in Custody

The detainee does not need to be treated, but the cell should be deemed out of use until it can be vacuumed and professionally cleaned with an insecticide solution. Any bedding or clothing should be handled with gloves and disposed of as appropriate.

Methicillin-Resistant Staphylococcus aureus

Epidemiology

Staphylococcus aureus is commonly carried on the skin or in the nose of healthy people. Approximately 25–30% of the population is colonised with the bacteria, but remain well [46]. From time to time, the bacteria cause minor skin infections that usually do not require antibiotic treatment. However, more serious problems can occur, e.g. infection of surgical wounds, drug injection sites, osteomyelitis, pneumonia or septicaemia. Over the last 50 years, the bacteria have become increasingly resistant to penicillin-based antibiotics [47] and in the last 20 years to an increasing number of alternative antibiotics. These multi-resistant bacteria are known as methicillin-resistant *S. aureus* (MRSA).

MRSA is prevalent worldwide. Like non-resistant staphylococci, it may remain undetected as a reservoir in colonised individuals, but can also produce clinical disease. It is more common among the elderly, debilitated or immunocompromised people or those with open wounds. Clusters of skin infections with MRSA have been reported among injecting drug users since 1981 in America [48, 49] and more recently similar strains have been found in the UK in IDUs in the community [50]. This may have particular relevance for the forensic physician when dealing with injecting drug users' sores. Immunocompetent people rarely get MRSA and should not be considered at risk. Between April 2003 and December 2008, there were 74 recorded cases of a community-acquired MRSA in injecting drug users in England and Wales [51].

Route of Transmission

The bacteria are usually spread via the hands of staff after contact with colonised or infected detainees or devices, items (e.g. bedding, towels, soiled dressings) or environmental surfaces that have been contaminated with MRSA-containing body fluids.

Management in Custody

With either known or suspected cases (consider all abscesses/ulcers of injecting drug users as infectious), standard precautions should be applied. Staff should wear gloves when touching mucous membranes, non-intact skin, blood or other body fluids or any items that could be contaminated. They should also be encouraged to wash hands with an antimicrobial agent whether or not gloves have been worn. After use, gloves should be disposed of in a yellow "hazard" bag and not allowed to touch surfaces. Masks and gowns should only be worn when carrying out procedures that generate aerosols of blood or other body fluids. Since this is an unlikely scenario in the custodial setting, they should not be necessary. Gloves should be worn when handling bedding or clothing and all items should be disposed of in the appropriate manner. Any open wounds should be covered as soon as possible. The cell should be cleaned professionally after use if there is any risk that it has been contaminated.

Other Bacteria Associated with Abscess Formation in Injecting Drug Users

Epidemiology

Over the last decade, there has been an increasing awareness of the bacterial flora colonising injection sites that may potentially lead to life-threatening infection [52]. In 1997, a sudden increase in needle abscesses caused by a clonal strain of Group A

Streptococcus was reported among hospitalised IDUs in Berne, Switzerland [53]. A recent study in the UK showed that the predominant isolate is *S. aureus*, with *Streptococcus* species forming just under one fifth (50% *beta-haemolytic* streptococci) [54]. There have also been reports of both non-sporing and sporing anaerobes (e.g. *Bacteroides* and *Clostridia* species including *Clostridium botulinum*) [55, 56]. In terms of numbers, in 2003–2004, injecting drug use was one of the most important risk factors for Group A streptococcal infection in the United Kingdom accounting for 20%. More recently, the number of cases has fallen year on year [51].

In particular, in 2000, laboratories in Glasgow were reporting isolates of *C. novyi* among IDUs with "serious unexplained illness". By 12 June 2000, a total of 42 cases (18 definite and 24 probable) had been reported. A definite case was defined as an IDU with both severe local and systemic inflammatory reactions. A probable case was defined as an IDU who presented to hospital with an abscess or other significant inflammation at an injecting site and had either a severe inflammatory process at or around an injection site or a severe systemic reaction with multiorgan failure and a high white cell count [57].

In the UK, the presence of *C. botulinum* in infected injection sites is a relatively new phenomenon. Up to the end of 1999, there were no cases reported to the PHLS. Since then the number has increased with a total of 13 cases in the UK and Eire being reported since the beginning of 2002. It is thought that these cases are associated with contaminated batches of heroin. Simultaneous injection of cocaine increases the risk by encouraging anaerobic conditions. Anaerobic flora in wounds may have serious consequences for the detainee but the risk of transmission to staff is virtually non-existent. By the end of 2008, a cumulative total of 132 suspected cases have been reported from the United Kingdom, with 86% of cases occurring in England. Four cases were reported in 2008 alone [51].

More recently in December 2009, two injecting drug users in Scotland died from anthrax contaminated heroin. Following this, two further deaths occurred in England in February 2010. An alert was issued first by the Department of Health and then, by the National Treatment Agency warning any drug user of the possible risks. Spores from the bacillus anthracis can contaminate heroin without any obvious signs. Anthrax can be acquired by injecting, smoking or inhaling heroin. Obvious symptoms include excessive swelling and redness at injection sites, fever, headache or shortness of breath when the heroin is smoked. Users are advised to go straight to the Emergency Department if they are at all worried. Such infections with spore forming bacteria will always occur from time to time. Healthcare practitioners should be mindful at all times.

Management in Custody

Staff should be reminded to wear gloves when coming into contact with detainees with infected skin sites exuding pus or serum and that any old dressings found in the cell should be disposed of into the yellow bag marked "clinical waste" in the medical room. Likewise, any bedding should be bagged and laundered or incinerated after use. The cell should be deemed out of use and professionally cleaned after the detainee has gone.

The healthcare professional managing the detainee should clean and dress open wounds as soon as possible to prevent the spread of infection. It may also be appropriate to start a course of antibiotics if there is abscess formation, signs of cellulitis and/or the detainee is systemically unwell. However, infections can often be low-grade because the skin, venous and lymphatic systems have been damaged by repeated penetration of the skin. In these cases, signs include lymphoedema, swollen lymph glands and darkly pigmented skin over the area. Fever may or may not be present, but septicaemia is uncommon unless the individual is immunocompromised (e.g. HIV positive). Co-Amoxiclav is the preferred treatment of choice as this covers majority of staphylococci, streptococci and anaerobes (the dose used is dependent on the degree of infection).

Necrotising fasciitis and septic thrombophlebitis are rare but life-threatening complications of iv drug use. Any detainee suspected of either of these needs hospital treatment. Advice about harm reduction should also be given. This includes encouraging drug users to smoke rather than inject or at least to advise them to avoid injecting into muscle or skin. Although most injecting drug users are aware of the risk of sharing needles, they may not realise that sharing any drug paraphernalia could be hazardous. Advice should be given to use the minimum amount of citric acid to dissolve the heroin as the acid can damage the tissue under the skin allowing bacteria to flourish. Drugs should be injected at different sites using fresh works for each injection. This is particularly important when "snowballing" as crack cocaine creates an anaerobic environment. Medical help should be requested if any injection site become painful and swollen or shows signs of pus collecting under the skin. Since intravenous drug users are at increased risk of acquiring HBV and HAV, they should be informed that vaccination against both diseases is advisable.

Another serious but relatively rare problem is the risk from broken needles in veins. Embolisation can take anything from hours to days or even longer if it is not removed. Complications may include endocarditis, pericarditis or pulmonary abscesses [58, 59]. IVDUs should be advised to seek medical help as soon as possible, and should such a case present in custody, then send the detainee straight to hospital.

Management of Human and Dog Bites

The Forensic Physician May Encounter Bites in Four Circumstances

1. During the examination of victims of assault (both children and adults) where presentation is more likely to be late
2. Among police officers bitten during the arrest of a detainee

3. In detainees during the arrest if dogs have been used
4. Where detainees have been involved in a fight either around the time of arrest or earlier

A detailed forensic examination of bites is given in Chap. 4. With any bite that has penetrated the skin, the goals of therapy are to minimise soft tissue deformity and to prevent or treat infection.

Epidemiology

In the UK and USA, dog bites represent approximately three-quarters of all bites presenting to Accident and Emergency departments [60]. A single dog bite can produce up to 220 psi of crush force in addition to the torsional forces as the dog shakes its head. This can result in massive tissue damage. Human bites may cause classical bites or puncture wounds (e.g. impact of fists on teeth) resulting in crush injuries.

Rates and Risks of Infection

An estimated 10–30% of dog bites and 9–50% of human bites lead to infection. Compare this with an estimated 1–12% of non-bite wounds managed in Accident and Emergency Departments.

The risk of infection is increased with puncture wounds, hand injuries, full thickness wounds, wounds requiring debridement, and those involving joints, tendons, ligaments or fractures.

Co-morbid medical conditions such as diabetes, asplenia, chronic oedema of the area, liver dysfunction, the presence of a prosthetic valve or joint and an immunocompromised state may also increase the risk of infection.

Other Complications of Bites

Infection may spread beyond the initial site, leading to septic arthritis, osteomyelitis, endocarditis, peritonitis, septicaemia and meningitis. Inflammation of the tendons or synovial lining of joints may also occur. If enough force is used, bones may be fractured or the wounds may be permanently disfiguring.

Initial Management

Assessment as to whether hospital treatment is necessary should be made as soon as possible. Always refer if the wound is bleeding heavily or fails to stop when pressure is applied. Penetrating bites involving arteries, nerves, muscles, tendons, the hands or feet or resulting in a moderate-to-serious facial wound, or crush injuries also require immediate referral.

If management within custody is appropriate, then ask about current tetanus vaccine status, HBV vaccination status and known allergies to antibiotics.

Wounds that have breached the skin should be irrigated with 0.9% (isotonic) sodium chloride or Ringer's lactate solution in preference to antiseptics, as the latter may delay wound healing.

A full forensic documentation of the bite should be made as detailed in Chap. 4.

Note if there are clinical signs of infection such as erythema, oedema, cellulitis, purulent discharge, or regional lymphadenopathy. Cover the wound with a sterile, non-adhesive dressing. Wound closure is not generally recommended as data suggest that this may increase the risk of infection. This is particularly relevant for non-facial wounds, deep puncture wounds, bites to the hand, clinically infected wounds, and those occurring more than 6–12 h before presentation. Head and neck wounds in cosmetically important areas may be closed if less than 12 h old and not obviously infected.

Pathogens Involved

1. Bacteria

   - Dog bites – *Pasteurella canis, P. multocida, S. aureus*, other staphylococci, *Streptococcus* species, *Eikenella corrodens*, *Corynebacterium* species and anaerobes including *Bacteroides fragilis* and *C. tetani*.
   - Human bites – *Streptococcus* species, *S. aureus, E. corrodens*, and anaerobes including *Bacteroides* (often penicillin resistant), peptostreptococci species, and *C. tetani*. TB and syphilis may also be transmitted.

2. Viruses

   - Dog bites – Outside of the UK, Australia and New Zealand, rabies should be considered. In the USA, domestic dogs are mostly vaccinated against rabies [61], and police dogs have to be vaccinated, so the most common source is from racoons, skunks and bats.
   - Human bites – HBV, HCV, HIV, and herpes simplex.

Antibiotic Prophylaxis

Antibiotics are not generally needed if the wound is more than 2 days old and there is no sign of infection or in superficial non-infected wounds evaluated early that can be left open to heal by secondary intention in compliant people with no significant co-morbidity [62]. Antibiotics should be considered with high-risk wounds that involve the hands, feet, face, tendons, ligaments, joints or suspected fractures or for any penetrating bite injury in a person with diabetes, asplenia, cirrhosis, or who is immunosuppressed.

Co-amoxiclav (amoxycillin and clavulanic acid) is the first-line treatment for mild–moderate dog or human bites resulting in infections managed in primary care. For adults, the recommended dose is 500/125 mg tds and for children 40 mg/kg tds (based on amoxycillin component). Treatment should be continued for 10–14 days. It is also the first-line drug for prophylaxis when the same-dose regime should be prescribed for 5–7 days. If the individual is known or suspected to be allergic to penicillin, then a tetracycline (e.g. doxycycline 100 mg bd) and metronidazole (500 mg tds) or an aminoglycoside (e.g. erythromycin) and metronidazole can be used. In the UK, doxycycline use is restricted to those over 12 and in the USA over 8 years old. Specialist advice should be sort for pregnant women.

Anyone with severe infection or who is clinically unwell should be referred to hospital. Tetanus vaccine should be given if the primary course or last booster was more than 10 years ago. Human tetanus immunoglobulin should be considered for tetanus-prone wounds (e.g. soil contamination, puncture wounds, signs of devitalised tissue, or for wounds sustained more than 6 h old). If the person has never been immunised or is unsure of their tetanus status, then a full three-dose course, spaced at least a month apart, should be given.

Management of Suspected Viral Infections from Human Bites

Penetrating bite wounds that involve only saliva may present a risk of HBV if the perpetrator belongs to a high-risk group. For management see "Disease Prevention" and "Management in Custody" in section "Hepatitis B". HCV and HIV are only a risk if blood is involved. The relevant management is dealt with in "Management in Custody" in section "Hepatitis C" and "Management in Custody of Staff/Victims in Contact with Disease" in section "Human Immunodeficiency Virus".

Infections Transmitted Through the Respiratory Route

General Information

Respiratory tract infections are common, are usually mild and self-limiting, though may require symptomatic treatment with paracetamol or a non-steroidal anti-inflammatory. These include the common cold (80% – rhinoviruses and 20% – coronaviruses), adenoviruses, influenza and parainfluenza, and during the summer and early autumn – enteroviruses. Special attention should be given to asthmatics or the immunocompromised detainee, as infection in these people may be more serious particularly if the lower respiratory tract is involved.

The following section includes respiratory pathogens of special note as they may pose a risk to both the detainee and/or staff who come into close contact.

Meningococcal Meningitis (Neisseria meningitidis)

General Information and Epidemiology

There are five serogroups of *Neisseria meningitidis*: A, B, C, W135 and Y. The prevalence of the different types varies from country to country. There is currently no available vaccine against type B, but two other vaccines (C and ACWY) are available. Overall, 10% of the UK population carry *N. meningitidis* (25% in the 15–19 age group) [63].

In the United Kingdom, most cases of meningitis are sporadic with less than 5% occurring as clusters (outbreaks) among school children. Between 1996 and 2000, 59% of cases were group B, 36% group C, and W135 and A accounted for 5%. There is a seasonal variation with a high level of cases in winter and a low level in the summer. The greatest risk group are the under 5s with a peak incidence under 1 year old. A secondary peak occurs in 15–19 years-old age group. In Sub-Saharan Africa, the disease is more prevalent in the dry season, but in many countries there is background endemicity all year round. The most prevalent serogroup is A.

Routine vaccination against group C was introduced in the UK in November 1999 for everybody up to the age of 18 and to all first-year university students. This has since been extended to include everyone under the age of 25. As a result of the introduction of the vaccination programme, there has been a 90% reduction of group C cases in the under 18s and an 82% reduction in those under 1 year old [64, 65].

An outbreak of serogroup W135 meningitis occurred among pilgrims on the Hajj in 2000. Cases were reported from many countries including the UK. In the UK, there is now an official requirement to be vaccinated with the quadrivalent vaccine (ACWY Vax) before going on a pilgrimage (Hajj or Umra), but illegal immigrants may enter the country who have not been vaccinated [66].

Symptoms

Following an incubation period of 3–5 days [67, 68], disease onset may either be insidious with mild prodromal symptoms or florid. Early symptoms and signs include malaise, fever and vomiting. Sever headache, neck stiffness, photophobia, drowsiness and a rash may develop. The rash may be petechial or purpuric and characteristically does not blanche under pressure. Meningitis in infants is more likely to be insidious in onset and lack the classical signs. In approximately 15–20% of cases, septicaemia is the predominant feature. Even with prompt antibiotic treatment, the case fatality rate is 3–5% in meningitis and 15–20% in those with septicaemia [33].

Period of Infectivity

A person should be considered infectious until the bacteria are no longer present in nasal discharge. With treatment, this is usually approximately 24 h.

Routes of Transmission

The disease is spread through infected droplets or direct contact from carriers or those who are clinically ill. It requires prolonged and close contact, so is a greater risk for people who share accommodation, utensils, and kiss. It must also be remembered that unprotected mouth-to-mouth resuscitation can also transmit disease.

Management in Custody

It is not possible to tell if a detainee is a carrier. Nevertheless, the risk of acquiring infection even from an infected and sick individual is low unless they have carried out mouth-to-mouth resuscitation. Any staff member who thinks they have been placed at risk should report to the Occupational Health Department (or equivalent) or the nearest emergency department at the earliest opportunity for vaccination.

If they have performed mouth-to-mouth resuscitation, then prophylactic antibiotics should be given before receiving vaccination. Rifampicin, ciprofloxacin and ceftriaxone can be used; however, ciprofloxacin has a number of advantages [69]. Only a single dose of 500 mg (adults and children over 12) is needed and has fewer side effects and contraindications than rifampicin. Ceftriaxone has to be given by injection and is therefore best avoided in the custodial setting.

If the staff member is pregnant, then advice should be sought from a consultant obstetrician, as ciprofloxacin is not recommended [70].

For anyone dealing on a regular basis with illegal immigrants (especially from the Middle East or Sub-Saharan Africa), e.g. immigration services, custody staff at designated stations, medical personnel and interpreters, should consider being vaccinated with ACWY Vax. A single injection provides protection for 3 years. Detainees suspected of disease should be sent directly to hospital.

Tuberculosis

Prevalence and Epidemiology

Human tuberculosis (TB) is caused by infection with *Mycobacterium tuberculosis, M. bovis* or *M. africanum*. It is a notifiable disease under legislation specific to individual countries, for example in the UK this comes under the Public Health (Control of Disease) Act 1984. In 1993, the WHO declared TB to be a global emergency with an estimated 7–8 million new cases and 3 millions deaths occurring each year, the majority of which were in Asia and Africa. However, these statistics are likely to be an underestimate since they are dependent on the accuracy of reporting, and in poorer countries, the surveillance systems are often inadequate through lack of funds.

Even in the UK, there has been an inconsistency of reporting particularly where an individual has concomitant infection with HIV. Some physicians found themselves caught in a dilemma of confidentiality until 1997, when the codes of practice were updated to encourage reporting with patient consent [71].

With the advent of rapid identification tests and treatment, and the use of BCG vaccination for prevention, TB declined during the first half of the twentieth century in the UK. However, since the early 1990s, numbers have slowly increased with some 6,800 cases reported in 2002 [72]. In 1998, 56% of reported cases were from people born outside the UK and 3% were associated with HIV infection [73, 74].

London has been identified as an area with a significant problem. This has been attributed to its highly mobile population, the variety of ethnic groups, a high prevalence of HIV, and the emergence of drug-resistant strains (1.3% in 1998 – PHLS unpublished data – Mycobnet).

A similar picture was initially found in the USA, when there was a reversal of a long-standing downward trend in 1985. However, between 1986 and 1992, the number of cases increased from 22,201 to 26,673 [75]. There were also serious outbreaks of multi-drug-resistant TB (MDR-TB) in hospitals in New York City and Miami [76]. Factors pertinent to the overall upswing included the emergence of HIV, the increasing numbers of immigrants from countries with a high prevalence of tuberculosis, and perhaps more significantly, the stopping of categorical federal funding for control activities in 1972. The latter led to a failure of the public health infrastructure for TB control. Since 1992, the trend has reversed as the CDC transferred most of its funds to tuberculosis surveillance and treatment programmes in states and large cities. From 1992 to 2001, the annual decline averaged by 7.3% [77], but the following year this was reduced to 2%, indicating that there was no room for complacency. The WHO has been proactive and redirecting funding to those countries most in need. In October 1998, a global partnership called Stop TB was launched to co-ordinate every aspect of TB control, and by 2002, the partnership had over 150 member states. A target was set to detect at least 70% of infectious cases by the year 2005.

The acquisition of tuberculosis infection is not necessarily followed by disease as the infection may heal spontaneously. It may take weeks or months before disease becomes apparent or infection may remain dormant for years before reactivation in later life especially if the person becomes debilitated or immunocompromised. Contrary to popular belief, the majority of cases of TB in immunocompetent people pass unnoticed. Of reported cases, 75% involve the lung, while non-respiratory (e.g. bone, heart, kidney, brain) or dissemination (miliary TB) are more common in immigrant ethnic groups and the immunocompromised [78]. They are also more likely to develop resistant strains. In the general population, there is an estimated 10% lifetime risk of tuberculosis infection progressing to disease [79].

Table 10.6 Symptoms of TB

Cough lasting >3 weeks
Fatigue
Anorexia and weight loss
Fever and night sweats
Mild haemoptysis (rusty coloured)
Cough with phlegm
Swollen lymph glands

There has been an increase in the number of cases of tuberculosis associated with HIV either due to new infection or reactivation. Tuberculosis infection is more likely to progress to active TB in HIV positive individuals with a greater than 50% lifetime risk [80]. TB can also lead to a worsening of HIV with an increase in viral load [81]. Therefore, the need for early diagnosis is paramount but it can be more difficult as pulmonary TB may present with non-specific features, e.g. bilateral, unilateral or lower lobe shadowing [82].

Symptoms of Pulmonary TB

After an incubation of 4–12 weeks, symptoms may develop (see Table 10.6).

Routes of Transmission

The main route is airborne through infected droplets, but prolonged or close contact is needed. Non-respiratory disease is not considered a risk unless the *Mycobacterium* is aerosolised under exceptional circumstances (e.g. during surgery) or there are open abscesses.

Period of Infectivity

A person is considered infectious as long as viable bacilli are found in induced sputum. Untreated or incompletely treated people may be intermittently sputum-positive for years.

Following 2 weeks of appropriate treatment, the individual is usually considered as non-infectious. This period is often extended for treatment of MDR-TB or for those with concomitant HIV. Patient compliance also plays an important factor.

At-Risk Groups

The risk of infection is directly proportional to the degree of exposure. More severe disease occurs in the malnourished, or the immunocompromised (e.g. HIV etc.) and substance misusers.

Immunocompromised people are at special risk of MDR-TB or *Mycobacterium avium-intracellulare* (MAI).

Management in Custody

Staff with disease should stay off work until the treatment course is complete and serial sputum samples no longer contain bacilli. Staff in contact with disease and have been vaccinated with BCG are at low risk of acquiring disease, but should minimise the time spent in the cell. Those who have not received BCG or who are immunocompromised should avoid contact with the detainee wherever possible. Detainees with MAI do not pose a risk to a staff member unless the latter is immunocompromised. Any staff member who is pregnant, regardless of BCG status or type of TB, should avoid contact all together.

Anyone performing mouth-to-mouth resuscitation with a person with untreated or suspected pulmonary TB should be regarded as a household contact and should report to Occupational Health or their GP if no other route exists. They should also be educated as to the symptoms of TB. Anyone who is likely to come into repeated contact with individuals at risk of TB should receive BCG (if they have not already done so) regardless of age, even though there is evidence to suggest that BCG administered in adult life is less effective. This does not apply to immunocompromised individuals or pregnant women. In the latter case, vaccination should preferably be deferred until after delivery.

Detainees with disease (whether suspected or diagnosed) who have not been treated or treatment is incomplete should be kept in custody for the minimum time possible. Immunocompromised individuals with TB are usually too ill to be detained, but if they are, they should be considered at greater risk of transmitting disease to staff. Any detainee with disease should be encouraged to cover their mouth and nose when coughing and sneezing.

Staff should wear gloves when in contact with the detainee and when handling clothing and bedding. Any bedding should be bagged after use and laundered or incinerated. The cell should be deemed out of action until it has been ventilated and professionally decontaminated, although there is no hard evidence to support that there is a risk of transmission from this route [73].

Severe Acute Respiratory Syndrome

General Information

On March 14 2003, the WHO issued a global warning to health authorities about a new atypical pneumonia called SARS. The earliest case was believed to have originated in the Guandong province of China on 16 November 2002. The causative agent was identified as a new Corona virus – SARS-CoV [83, 84]. By the end of June 2003, 8,422 cases had been reported from 31 different countries with a total of

916 deaths. Approximately 92% of cases occurred in China (including Hong Kong, Taiwan and Macao). The case fatality rate varied from <1% in people less than 24 years old, 6% in persons aged 25–44, 15% in the 44–64 years age group and >50% in persons 65 or older. On 5 July 2003, the WHO reported that the last human chain of transmission of SARS had been broken and lifted the ban from all countries. However, they warned that everyone should remain vigilant, as resurgence of SARS was still a possibility and this indeed proved the case with reports ongoing until May 2004. Since then, there have been no further reported cases. Knowledge about the epidemiology and ecology of SARS-CoV and the disease remains limited; however, the experience gained from the previous outbreak enabled the disease to be contained rapidly – reflected in the few cases reported since December. There is still no specific treatment or preventative vaccine that has been developed to date.

Incubation Period and Symptoms

The incubation period is short – around 3–6 days (maximum 10 days), and despite the media frenzy surrounding the initial outbreak, SARS is less infectious than influenza. The following clinical case definition of SARS has been developed for public health purposes [85].

A person with a history of:

- Fever (at least 38°C)
- And, one of more symptoms of lower respiratory tract illness (cough, difficulty in breathing, dyspnoea)
- And, radiographic evidence of lung infiltrates consistent with pneumonia or Respiratory Distress Syndrome, or post mortem findings of the above with no identifiable cause
- And, no alternative diagnosis can fully explain the illness

Laboratory tests have been developed which include detection of viral RNA by PCR from nasopharyngeal secretions or stool samples, detection of antibodies by ELISA or IFA in the blood, and viral culture from clinical specimens.

Route of Transmission

Available information suggests that close contact via aerosol or infected droplets from an infected individual provides the highest risk of acquiring disease. Most cases occurred in hospital workers caring for an index case or their close family members.

Management in Custody

Despite the re-emergence of SARS, it is highly unlikely that a case will be encountered in the custodial setting at the time of writing. However, forensic physicians need to remain alert for the symptoms of SARS and keep up-to-date with recent outbreaks. Information can be obtained from the WHO on a daily basis from their web site. If SARS is suspected, then medical staff should wear gloves and a surgical mask when examining a suspected case; however, masks are not usually available in custody. Anyone suspected of SARS must be sent immediately to hospital and staff who have had prolonged close contact should be alerted as to the potential symptoms.

Infections Transmitted Through the Faecal-Oral Route

General Considerations

The most consistent feature of diseases transmitted through the faecal-oral route is diarrhoea (see Table 10.7). Infective agents include bacteria, viruses and protozoa. Since the causes are numerous, it is beyond the remit of this chapter to cover them all. It is safest to treat all diarrhoea as infectious unless the detainee has a proven non-infectious cause (e.g. Crohn's disease, ulcerative colitis).

All staff should wear gloves when in contact with the detainee or handling clothing, bedding etc. and contaminated articles should be laundered or incinerated. The cell should be professionally cleaned after use paying particular attention to the toilet area.

Hepatitis A

Epidemiology and Prevalence

This viral hepatitis occurs worldwide with variable prevalence. It is highest in countries where hygiene is poor and infection occurs all year round. In temperate climates, the peak incidence is in autumn and winter, but the trend is becoming less marked.

All age groups are susceptible if they are non-immune or have not been vaccinated. In developing countries, the disease occurs in early childhood, whereas the reverse is true in countries where the standard of living is higher.

In the UK, there has been a gradual decrease in the number of reported cases from 1990 to 2000 [86, 87]. This is due in part to improved standards of living and the introduction of an effective vaccine. The highest incidence occurs in the 15–34-year-old age group. Approximately 25% of people over the age of 40 have natural immunity leaving the remainder susceptible to infection [88].

Small clusters occur from time to time, associated with a breakdown in hygiene. There is also an increasing incidence of HAV in gay or bisexual men and their partners [89]. An unpublished study in London in 1996 showed a seroprevalence of 23% among gay men (Young Y et al., unpublished).

Table 10.7 Common causes of infective diarrhoea

Cause	Symptoms	Incubation	Infectivity	Notes
Campylobacter	C, F, N, V, BD	1–10 Days	Untreated – 7 weeks	Requires antibiotics Seek advice Acute phase exclude from custody
E. coli O157:H7	BD (or WD), F unusual	3–8 Days	Up to 7 days	Person to person spread Can be serious with TTP, HUS, dehydration Seek advice
Norwalk virus	N, V, D, AP, mild F	24–48 h	Up to 48 h after diarrhoea stops	Mild to moderate. Self-limiting
Rotavirus	F, V, WD	24–72 h	Up to 8 days Up to 30 days in immuno-compromised	Symptomatic treatment Persists in environment
Salmonella	H, AP, D, N, F, ±V	6–72 h	Days to weeks	Persistent carriage can occur Requires antibiotics Seek advice
Shigella	DY/WD, F, N, (C, V)	12–96 h	Up to 4 weeks	Usually mild in U.K Can be severe in IC Requires antibiotics in custody Take advice Person to person spread

AP Abdominal pain; *H* headache; *BD* bloody diarrhoea; *HUS* haemolytic-uraemic syndrome; *C* cramps; *IC* immunocompromised; *D* diarrhoea; *N* nausea; *DY* dysentery (blood and mucus); *TTP* thrombotic thrombocytopaenic purpura; *F* fever; *V* vomiting; *WD* watery diarrhoea

Symptoms

The clinical picture ranges from asymptomatic infection through a spectrum to fulminant hepatitis. Unlike HBV and HCV, HAV does not persist or progress to chronic liver damage. Infection in childhood is often mild or asymptomatic, but in adults tends to be more severe.

Following an incubation period of 15–50 days (mean 28 days), symptomatic infection starts with the abrupt onset of jaundice anything from 2 days to 3 weeks after the anicteric phase. It lasts for approximately the same length of time and is often accompanied by a sudden onset of fever.

HAV infection can lead to hospital admission in all age groups, but is more likely with increasing age as is the duration of stay.

The overall mortality is less than 1%, but 15% of people will have a prolonged or relapsing illness over 6–9 months (CDC Fact sheet). Fulminant hepatitis occurs in <1% of people, but is more likely over the age of 65 or in those with pre-existing liver disease. In hospitalised patients, case fatality ranges form 2% in 50–59 year olds to nearly 13% in those older than 70 years [87].

Period of Infectivity

The individual is most infectious in the 2 weeks before the onset of jaundice when they are asymptomatic. This can make control of infection difficult since the disease is not recognised.

Routes of Transmission

The main route is faecal-oral through the ingestion of contaminated water and food. It can also be transmitted by close personal contact including homosexuals practising anal intercourse and fellatio. There is a very slight risk from blood transfusions if the donor is in the acute phase of infection. It should not be considered a risk from needlestick injuries unless clinical suspicion of HAV is high.

Risk Groups

Risk groups include the homeless, homosexuals, IVDUs, travellers abroad who have not been vaccinated, patients with chronic liver disease and chronic infection with HBV and HCV, employees and residents in day-care centres and hostels, sewage workers, laboratory technicians and those handling non-human primates.

Several large outbreaks have occurred among injecting drug users – some with an epidemiological link to prisons [90, 91]. Transmission occurs during the viraemic phase of the illness through sharing injecting equipment and via faecal-oral routes because of poor living conditions [92]. There have also been reports of HAV being transmitted through drugs that have been carried in the rectum. A study in Vancouver showed that 40% of injecting drug users had past infection of HAV and they also showed an increased prevalence among men who have sex with men [93].

Management in Custody

Staff with disease should report to Occupational Health and stay off work until the end of the infective period. Those in contact with disease (either through exposure at home or from an infected detainee) should receive prophylactic treatment as soon as possible (see below).

To minimise the risk of acquiring disease in custody, staff should wear gloves when dealing with the detainee then wash their hands thoroughly. Gloves should only be disposed of in the clinical waste bags.

Detainees with disease should be kept in custody for the minimum time possible. They should only be sent to hospital if fulminant hepatitis is suspected. The cell should be quarantined after use and professionally cleaned. Any bedding or clothing should be handled with gloves and laundered or incinerated according to local policy. Detainees reporting contact with disease should be given prophylactic treatment as soon as possible (see section "Prophylaxis and Treatment").

Prophylaxis and Treatment

Contacts of HAV should receive HAV vaccine (e.g. Havrix Monodose or Avaxim) if they have not been previously immunised or had disease. Human normal immunoglobulin (HNIG) 500 mg deep im in gluteal muscle should be used in the following circumstances:

- The contact is over 50.
- Has cirrhosis or pre-existing HBV, HCV, or HDV.
- Contact has occurred >8 days but <28 days from exposure.

Staff at higher risk of coming in contact with HAV should consider being vaccinated prior to exposure. Two doses of vaccine given 6–12 months apart give at least 10 years of protection.

There is no specific treatment for HAV except supportive measures and symptomatic treatment.

Exotica

Although the chance of encountering a tropical disease in custody is small, it is worth bearing in mind. It is not necessary for a forensic physician to be able to diagnose the specific disease, but simply to recognise that the detainee/staff member is ill and whether or not they need to be sent to hospital (see Tables 10.8–10.10).

Table 10.8 Suspicion of exotica? History and examination aide memoir

Has the detainee travelled to Africa, South East Asia, the Indian Sub-continent, Central/South America or the Far East in the last 6–12 months

Ascertain whether they received any vaccinations prior to travel and what

Ask if they took malaria prophylaxis, what type and whether they completed the course

Ask if they swam in any stagnant lakes during the trip

If yes to any of the above, ask if they have experienced any of the following symptoms:

- A fever/hot or cold flushes/shivering
- Diarrhoea ±abdominal cramps ±blood or slime in the stool
- A rash
- Persistent headaches ±light sensitivity
- Nausea or vomiting
- Aching muscles/joints
- A persistent cough (dry or productive) lasting at least 3 weeks
  - Take temperature
  - Check skin for signs of a rash and note nature and distribution
  - Check throat
  - Listen carefully to the lungs for signs of infection/consolidation

Table 10.9 Tropical diseases that present with fever

Disease	Countries	Incubation	Transmission	Management
Dengue	Most hot climates	3–14 Days	Mosquito No person to person in UK	Symptomatic
Hantavirus	Eastern Europe	2 Days to 8 weeks	No person to person in UK	Symptomatic
Lassa Fever	West Africa			Hospital
Malaria	Sub-Saharan Africa SE. Asia S. America	7 Days to 1 year	Mosquito No person to person in UK	Requires urgent treatment Hospital
Typhoid	Hot climates	Up to 72 h	Oral-faecal	Requires antibiotics
Yellow fever	Sub-Saharan Africa Parts of South America	3–6 Days	Mosquito No person to person in UK	Hospital

Table 10.10 Tropical diseases that present with diarrhoea

Disease	Incubation	Infectivity	Transmission	Management
Amoebic dysentery	Days to months	Years	Oral-faecal	Requires antibiotics
Cholera	Hours to 5 days	3–5 Days after recovery	Oral-faecal Vomit	Requires antibiotics
Giardia	3–25 Days	Months	Oral-faecal	Treat with tinidazole
Malaria	7 Days to 1 year	None	No person to person	Urgent treatment Hospital
Typhoid	Up to 72 h	Days to weeks	Oral-faecal	Requires antibiotics

This is best achieved by knowing the right questions to ask and carry out the appropriate examination. Tables 10.8–10.10 should be used as an aide memoir in order not to miss some more unusual diseases.

References

1. UK Health Guidelines (1998) Guidance for clinical health care workers: protection against infection with blood-borne viruses: recommendations of the Expert Advisory Group on AIDS and the Advisory Group on Hepatitis [HSC 1998/063]. NHS Executive, London, UK
2. Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force (2002) Guidelines for hand hygiene in health care settings. MMWR Morb Mortal Wkly Rep 51:1–44
3. National Occupational Health and Safety Committee (1994) National model regulations for the control of workplace hazardous substances. Commonwealth of Australia [NOHSC:1005]
4. Nicholson F (2009) Infectious diseases and an at risk exposure (Chapter 4). In: Stark MM, Rogers DJ, Norfolk GA (eds) Good practice guidelines for forensic medical examiners, 2nd edn. Royal Military Police, Oxford, UK
5. Bolyard EA, Tablan OC, Williams WW, Pearson ML, Shapiro CN, Deitchman SD; and the Hospital Infection Control Practices Advisory Committee (1998) Guideline for infection control in health care personnel. Am J Infect Control 26:289–354
6. Report from the Unlinked Anonymous Surveys Steering Group (2001) Prevalence of HIV and hepatitis infections in the United Kingdom 2000. Annual report of the Unlinked Anonymous Prevalence Monitoring Programme. Department of Health, London, UK
7. (2002) A strategy for infectious diseases – progress report. Blood-borne and sexually transmitted viruses: hepatitis. Department of Health, London, UK
8. Centers for Disease Control (CDC) (1988) Perspectives in disease prevention and health promotion update. Universal precautions for prevention of transmission of human immunodeficiency virus, hepatitis B virus and other bloodborne pathogens in health-care settings. MMWR Morb Mortal Wkly Rep 37:377–388
9. Martinson FE, Weigle KA, Royce RA, Weber DJ, Suchindran CM, Lemon SM (1998) Risk factors for horizontal transmission of hepatitis B in a rural district in Ghana. Am J Epidemiol 147:478–487
10. Verma G, Dalai P, Bapat M, Rathi P, Abraham P (2003) Familial clustering of hepatitis B infection: study of a family. Indian J Gastroenterol 22:22–23
11. Erol S, Ozkurt Z, Ertek M, Tasyaran MA (2003) Intrafamilial transmission of hepatitis B in the Eastern Anatolian region of Turkey. Eur J Gastroenterol Hepatol 15:345–349
12. Hutchinson S, Goldberg D, Gore S et al (1998) Hepatitis B outbreak at Glenochil prison during January to June 1993. Epidemiol Infect 121:185–191
13. Christensen PB et al (1998) European network for HIV/AIDS and hepatitis prevention in prisons. Second annual report. The Network, Bonn and Marseille
14. Weild AR, Gill ON, Bennett D, Livingstone SJM, Parry JV, Curran L (2000) Prevalence of HIV, hepatitis B and hepatitis C antibodies in prisoners in England and Wales; a national survey. Commun Dis Public Health 3:121–126
15. Alter MJ (1997) The epidemiology of acute and chronic hepatitis C. Clin Liver Dis 1:559–562
16. Frank C, Mohamed MK, Strickland GT (2000) The role of the parenteral antischistosomal therapy in the spread of hepatitis C virus in Egypt. Lancet 355:887–891
17. (2003) Chronic hepatitis C: disease management. NIH publication No. 03-4230 Feb 2003. www.digestive.niddk.nih.gov/diseases/pubs/chronichepc/index.htm. Accessed 15 June 2011
18. Chief Medical Examiner, Sir Liam Donaldson (2002) Hepatitis C strategy for England. Department of Health, London, UK
19. Gish RG, Lau JYN (1997) Hepatitis C virus: eight years old. Viral Hepat Rev 3:17–37

20. Ramsay ME, Balogun MA, Collins M, Balraj V (1998) Laboratory surveillance of hepatitis C virus in England and Wales: 1992–1996. Commun Dis Public Health 1:89–94
21. Interferon alfa (pegylated and non pegylated) and ribavirin for the treatment of chronic hepatitis C. Technology Appraisal 75 (2004) http://www.nice.org.uk/nicemedia/pdf/TA075guidance.pdf. Accessed Jan 2010
22. Peginterferon alfa and ribavirin for the treatment of mild chronic hepatitis C. NICE technology appraisal guidance 106 (2006) http://www.nice.org.uk/nicemedia/pdf/TA106guidance.pdf. Accessed Jan 2010
23. Hepatitis D, Sean R Lacey, Assistant Professor, Department of Medicine, Case Western Reserve University). http://emedicine.medscape.com/article/178038-overview. Last modified June 2011
24. (2003) Cumulative UK data to end of December 2002. AIDS/HIV quarterly surveillance tables provided by the PHLS AIDS centre (CDSC) and the Scottish centre for Infection and Environmental Health. No 57: 02/4
25. Testing Times. HIV and other sexually transmitted infections in the United Kingdom (2007). http://www.hpa.org.uk/web/HPAweb_C/1203496897276. Accessed June 2011
26. International Perinatal HIV Group (1999) Mode of vertical transmission of HIV-1: a metanalysis of fifteen prospective cohort studies. N Engl J Med 340:977–987
27. Duong T, Ades A, Gibbs DM et al (1999) Vertical transmission rate for HIV in the British Isles estimated on Surveillance data. BMJ 319:1227–1229
28. Limb S, Kawar M, Forster GE (2002) HIV post-exposure prophylaxis after sexual assault: the experience of a sexual assault service in London. Int J STD AIDS 13:602–605
29. HIV post-exposure prophylaxis. Evidence from the UK Chief Medical Officers' Expert Advisory Group on AIDS (2008). http://www.dh.gov.uk/dr_consum_dh/groups/dh_digitalassets/@dh/@en/documents/digitalasset/dh_089997.pdf. Accessed Jan 2010
30. (2000) HIV post-exposure prophylaxis: guidance from the UK Chief Medical Officer's Expert Advisory Group on AIDS. UK Health Department, London, UK
31. Jochimsen EM (1997) Failures of zidovudine post exposure prophylaxis. Am J Med 102: 52–55
32. Hawkins DA, Asboe D, Barlow K, Evans B (2001) Seroconversion to HIV-1 following a needlestick injury despite combination post-exposure prophylaxis. J Infect 43:12–15
33. Salisbury DM, Begg NT (1996) Immunisation against infectious disease. Her Majesty's Stationery Office, London, UK
34. Sinha DP (1996) Chickenpox – disease predominantly affecting adults in rural West Bengal. Int J Epidemiol 5:367–374
35. Centers for Disease Control and Prevention (1996) Prevention of *varicella*: recommendations of the Advisory Committee on Immunization Practices. MMWR Morb Mortal Wkly Rep 45:1–36
36. Fairley CK, Miller E (1996) *Varicella-zoster* virus epidemiology. A changing scene? J Infect Dis 174(suppl 3):314–319
37. Smego RA, Asperilla MO (1991) Use of Acyclovir for *varicella* pneumonia during pregnancy. Obstet Gynecol 78:1112–1116
38. Pastuszak AL, Levy M, Schick B et al (1994) Outcome after maternal varicella infection in the first 20 weeks of pregnancy. N Engl J Med 330:901–905
39. Miller E, Cradoc-Watson JE, Ridehalgh MK (1989) Outcome in newborn babies given anti-*varicella zoster* immunoglobulin after perinatal maternal infection with *varicella zoster* virus. Lancet 2:371–373
40. Gilden DH, Vafai A, Shtram Y et al (1983) *Varicella-zoster* virus DNA in human sensory ganglia. Nature 306:478–480
41. Dworkin RH, Schmader KE (2001) Epidemiology and natural history of herpes zoster and post herpetic neuralgia. In: Watson CPN, Gershon AA (eds) Herpes zoster and postherpetic neuralgia, 2nd edn. Elsevier, New York, NY, pp 39–64
42. Desmond RA, Weiss HL, Arani RB et al (2002) Clinical applications for change-point analysis of herpes zoster pain. J Pain Symptom Manage 23:510–516
43. Gnann JW Jr, Whitley RJ (2002) Herpes zoster. N Engl J Med 347:340–346

44. Haustein UF, Hlawa B (1989) Treatment of scabies with permethrin versus lindane and benzoyl benzoate. Acta Derm Venereol 69:348–351
45. Brown S, Becher J, Brady W (1995) Treatment of ectoparasitic infections; review of the English-language literature 1982–1992. Clin Infect Dis 20(suppl 1):S104–S109
46. Klutymans J, Van Belkum A, Verbrugh H (1989) Nasal carriage of *Staphylococcus aureus*: epidemiology and control measures. Infect Dis Clin North Am 3:901–913
47. Lowry FD (1998) *Staphylococcus aureus* infections. N Engl J Med 339:520–532
48. Centers for Disease Control and Prevention (1981) Community-acquired methicillin-resistant *Staphylococcus aureus* infections – Michigan. MMWR Morb Mortal Wkly Rep 30:185–187
49. Saravolatz LD, Markowitz N, Arking L, Pohlod D, Fisher E (1982) Methicillin-resistant *Staphylococcus aureus*, epidemiologic observations during a community acquired outbreak. Ann Intern Med 96:11–16
50. Health Protection Agency (2003) Emergence of PVL-producing strains of *Staphylococcus aureus*. Commun Dis Rep CDR Wkly [serial online] 13. http://www.phls.org.uk/publications. Accessed Jan 2004
51. Shooting Up. Infections among injecting drug users in the United Kingdom 2008. An update (2009). http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1254510657318. Accessed Jan 2010
52. Summanen PH, Talan DA, Strong C et al (1995) Bacteriology of skin and soft tissue infections: comparison of infections in intravenous drug users and individuals with no history of intravenous drug use. Clin Infect Dis 20(suppl 2):S279–S282
53. Bohlen LM, Muhlemann K, Dubuis O, Aebi C, Tauber MG (2000). Outbreak among drug users caused by a clonal strain of group a *Streptococcus*. Dispatches – emerging infectious diseases. http://www.cdc.gov. Accessed Mar 2003. Emerg Infect Dis. 6(2):175–179
54. Lettington W (2002) Bacteriological skin and subcutaneous infections space in injecting drug users – relevance for custody. J Clin Forensic Med 9:65–69
55. Passaro DJ, Werner SB, McGee J, MacKenzie WR, Vugia DJ (1998) Wound botulism associated with black tar heroin among injecting drug users. JAMA 279:859–863
56. Brazier JS, Duerden BI, Hall V et al (2002) Isolation and identification of *Clostridium* spp from infections associated with injection of drugs: experiences of a microbiological investigation team. J Med Microbiol 51:985–989
57. Greater Glasgow Health Board, SCIFH (2001) Unexplained illness among drug injectors in Glasgow. Eurosurveillance 4:500518
58. Kuylaylat MN, Barakat N, Stephan RN, Gutierrez I (1993) Embolization of illicit needle fragments. J Emerg Med 11:403–408
59. Ngaage DL, Cowen ME (2001) Right ventricular needle embolus in an injecting drug user: the need for early removal. Emerg Med J 18:500–501
60. Spanierman C (2004) Departments of Emergency Medicine and Pediatrics, Lutheran General Hospital of Oak Brook, Advocate Health System. eMedicine-Human Bites. http://www.emedicine.com/ped/topic246.htm. Accessed Feb 2004
61. Presutti JP (2001) Prevention and treatment of dog bites. Am Fam Physician 63:1567–1572
62. Revis DR, Jr, Seagel MB (2003) Human bites. Department of Plastic Surgery, University of Florida College of Medicine. eMedicine-Human Bites. http://www.emedicine.com/ent/topic728.htm. Accessed Feb 2004
63. PHLS (2002) Guidelines for public health management of meningococcal diseases in the UK. Commun Dis Public Health 5:187–204
64. Miller E, Salisbury D, Ramsay M (2001) Planning, registration and implementation of an immunisation campaign against meningococcal serogroup C disease in the UK: a success story. Vaccine 20(suppl 1):S58–S67
65. Ramsay M, Andrews N, Kaczmarski E, Miller E (2001) Efficacy of meningococcal serogroup C conjugate vaccine in teenagers and toddlers in England. Lancet 357:195–196
66. PHLS (2001) Quadrivalent meningoimmunisation required for pilgrims to Saudi Arabia. Commun Dis Rep CDR Wkly 11. http://www.phls.org.uk/publications. Accessed 11 May 2004
67. Boutet R, Stuart JM, Kaczmarski E, Gray SJ, Jones M, Andrews N (2001) Risk of laboratory-acquired meningococcal disease. J Hosp Infect 49:282–284

68. Orr H, Kaczmarski E, Sarangi J, Pankhania B, Stuart J (2001) Cluster of meningococcal disease in rugby match spectators. Commun Dis Public Health 4:316–317
69. CDSC (2001) Ciprofloxacin as a chemoprophylactic agent for meningococcal disease – low risk of anaphylactoid reactions. Commun Dis Rep CDR Wkly 11:45
70. Joint Formulary Committee (2002–2003) British National Formulary. British Medical Association and Royal Pharmaceutical Society of Great Britain, London, UK
71. Omerod LP, Watson JM, Pozniak A et al (1997) Notification of tuberculosis an updated code of practice for England and Wales. J R Coll Physicians Lond 31:299–303
72. Statutory notifications to the Communicable Disease Surveillance Centre(2002). Preliminary annual report on tuberculosis cases reported in England, Wales, and N. Ireland. http://www.hpa.org.UK/infections. Accessed Dec 2003
73. The Interdepartmental Working Group on Tuberculosis (1998) The prevention and control of tuberculosis in the United Kingdom: UK guidance on the prevention and control of transmission of 1. HIV-related tuberculosis 2. Drug-resistant, including multiple drug-resistant, tuberculosis. Department of Health, Scottish Office, The Welsh Office, Scotland
74. Joint Tuberculosis Committee of the British Thoracic Society (2000) Control and prevention of tuberculosis in the United Kingdom: code of practice 2000. Thorax 55:887–901
75. Cantwell MF, Snider DE, Cauthen GM, Onorato IM (1994) Epidemiology of tuberculosis in the United States, 1985 through 1992. JAMA 272:535–539
76. Centers for Disease Control (1991) Nosocomial transmission of multi-drug resistant tuberculosis among HIV-infected persons – Florida, New York, 1988–1991. MMWR Morb Mortal Wkly Rep 40:585–591
77. Navin TR, McNabb SJN, Crawford JT (2002) The continued threat of tuberculosis. Emerg Infect Dis [serial online]. http://www.cdc.gov/ncidod/EID/vol8no11/02–0468. Accessed Nov 2002
78. Sepkowitz DV (1995) Tuberculosis in HIV-infected individuals (Chapter 5). In: Lutwick LI (ed) Tuberculosis – a clinical handbook. Chapman & Hall Medical, London, UK
79. Murray JF (1989) The White Plague: down and out, or up and coming? Am Rev Respir Dis 140:1788–1795
80. Selwyn PA, Hartel D, Lewis VA et al (1989) A prospective study of the risk of tuberculosis among intravenous drug users with human immunodeficiency virus infection. N Engl J Med 320:545–550
81. Wallis RS, Vjecha M, Amir-Tahmasseb M et al (1993) Influence of tuberculosis on human immunodeficiency virus (HIV-1): enhanced cytokine expression and elevated B_2-microglobulin in HIV-1 associated tuberculosis. J Infect Dis 167:43–48
82. Long R, Maycher B, Scalcini M, Manfreda J (1991) The chest roenterogram in pulmonary tuberculosis patients seropositive for human immunodeficiency virus type 1. Chest 99:123–127
83. Peiris JSM, Lais T, Poon LLM et al (2003) Coronavirus as a possible cause of severe acute respiratory syndrome. Lancet 361:1319–1325
84. Donnelly CA, Ghani AC, Leung GM et al (2003) Epidemiological determinants of spread of causal agents of severe acute respiratory syndrome in Hong Kong. Lancet 361:761–766
85. World Health Organization. Alert, verification and public health management of SARS in post-outbreak period (2003) http://www.who.int/csr/sars/postoutbreak/en/. Accessed 14 Dec 2003
86. Gay NJ, Morgan-Capner P, Wright J, Farrington CP, Miller E (1994) Age-specific antibody prevalence to hepatitis A in England: implications for disease control. Epidemiol Infect 113:113–120
87. Crowcroft NS, Walsh B, Davison KL, Gungabissoon U; PHLS Advisory Committee on Vaccination and Immunisation (2001) Guidelines for the control of hepatitis A infection. Commun Dis Public Health 4:213–227
88. Irwin DJ, Millership S (1999) Control of a community hepatitis A outbreak using hepatitis A vaccine. Commun Dis Public Health 2:184–187
89. Katz MH, Hsu L, Wong E, Liska S, Anderson L, Janssen RS (1997) Seroprevalence of and risk factors for hepatitis A infection among young homosexual and bisexual men. J Infect Dis 175:1225–1229

90. Harkess J, Gildon B, Istre GR (1989) Outbreaks of hepatitis A among illicit drug users, Oklahoma, 1984–1987. Am J Public Health 79:463–466
91. Hutin YJ, Bell BP, Marshall KL et al (1999) Identifying target groups for a potential vaccination program during a hepatitis A community outbreak. Am J Public Health 89:918–919
92. Hutin YJ, Sabin KM, Hutwagner LC et al (2000) Multiple modes of hepatitis A transmission among metamphetamine users. Am J Epidemiol 152:186–192
93. Ochnio JJ, Patrick D, Hom TG et al (2001) Past infection with hepatitis A among Vancouver Street youth, injection drug users and men who have sex with men; implications for vaccination programmes. CMAJ 165:293–297

Chapter 11
Fitness to Be Interviewed

Guy A. Norfolk and Margaret M. Stark

Introduction

The custodial interrogation of suspects is an essential component of all systems of criminal investigation. The confessions and other incriminating statements that are obtained during these interrogations have always played an important role in prosecutions and continue to be relied on as evidence of guilt in a substantial number of trials. For example, in England and Wales, confessions have been found to provide the single-most important piece of evidence against defendants in the Crown Court, being crucial in about 30% of cases [1]. Similarly, an influential American observational study found that interrogation was necessary for solving the crime in about 17% of cases [2]. The quest to obtain confessions from the mouths of suspects has seen a slow and uneven move away from the inquisitions aided by torture and oppression of the Middle Ages toward the doctrine that:

> *A free and voluntary confession is deserving of the highest credit, because it is presumed to flow from the strongest sense of guilt and therefore it is admitted as proof of the crime to which it refers; but a confession forced from the mind by the flattery of hope or by the torture of fear comes in so questionable a shape when it is to be considered as the evidence of guilt, that no credit ought to be given to it; and therefore it is rejected* [3].

In the years since this judgment, considerable effort has been expended on attempting to regulate the custodial interview in order to minimize the risk of false confessions while preserving the value of interrogation as a means of solving crime. In this section, we will consider the important psychological aspects of interrogation and

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confession and then discuss the role the forensic physician can play in ensuring that suspects are fit to be interviewed.

Police Interview Techniques

A number of American manuals detail the way in which coercive and manipulative interrogation techniques can be employed by police officers to obtain a confession [4, 5], with similar techniques being advocated by Walkley [6] in the first such manual written for British officers. The authors of these manuals propound various highly effective methods for breaking down a suspect's resistance while justifying a certain amount of pressure, deception, persuasion, and manipulation as necessary in order for the "truth" to be revealed. Walkley acknowledges that "if an interviewer wrongly assesses the truth-teller as a lie-teller he may subject that suspect to questioning of a type which induces a false confession." Generally, however, the manuals pay scant attention to the fact that, in certain circumstances, the techniques they recommend may make a suspect confess to a crime he or she did not commit. Although studies in the United Kingdom have suggested that coercive interview techniques are employed less frequently than in the past, manipulative and persuasive tactics continue to be used, particularly in relation to more serious crimes [7–9].

Interrogators are encouraged to look for nonverbal signs of anxiety, which are often assumed to indicate deception. However, the innocent as well as the guilty may exhibit signs of nervousness. Innocent suspects may be anxious because they are erroneously being accused of being guilty, because of worries about what is going to happen to them while in custody, and possibly because of concerns that the police may discover some previous transgression. Furthermore, there are three aspects of a police interview that are likely to be as stressful to the innocent as to the guilty: the stress caused by the physical environment in the police station, the stress of being isolated from family and friends, and the stress caused by the suspect's submission to authority. All these factors can markedly impair the performance of a suspect during interview. Indeed, American research has suggested that for most suspects interrogations are likely to be so stressful as to impair their judgment on such crucial matters as the exercise of legal rights [10].

Given the interview techniques employed by the police and the stresses interrogation places on the accused, there is little wonder that false confessions are occasionally made to the police.

False Confessions

During the last two decades of the twentieth century, the United Kingdom witnessed a number of well-publicized miscarriages of justice in which the convictions depended heavily on admissions and confessions made to the police that were subsequently shown to be untrue [11–13]. In reviewing 70 earlier wrongful imprisonments that occurred between the years 1950 and 1970, Brandon and Davies [14] found that false confessions were second only to incorrect identification evidence as the most common cause of wrongful conviction. More recently, in 1994, Justice [15] identified 89 cases in which an alleged miscarriage of justice rested on a disputed confession. Thus, it is clear that people can and do make false and misleading admissions against their own interest. We need to turn to modern psychology to obtain insights into why this might happen.

Why Make a False Confession?

There is no single reason why people falsely confess to crimes they have not committed. Indeed, such confessions usually result from a combination of factors unique to the individual case. Nonetheless, Kassin and Wrightsman [16] have been able to identify three distinct types of false confession, which have been developed by Gudjonsson [17] and expanded in two respects by Shepherd [18]. These categories are voluntary, accommodating-compliant, coerced-compliant, and coerced-internalized.

Voluntary False Confessions

Voluntary false confessions are offered by individuals without any external pressure from the police. Commonly the individuals go voluntarily to the police to confess to a crime they may have read about in the press or seen reported on television. Often they do so out of a morbid desire for notoriety, the individual seeming to have a pathologic desire to become infamous, even at the risk of facing possible imprisonment.

Alternatively, a voluntary false confession may result from the individual's unconscious need to expiate guilt feelings through receiving punishment. The guilt may concern real or imagined past transgressions or, occasionally, may be part of the constant feeling of guilt felt by some individuals with a poor self-image and high levels of trait anxiety.

By contrast, some people making this type of confession do so because they are unable to distinguish between fact and fantasy. Such individuals are unable to differentiate between real events and events that originate in their thinking, imagination, or planning. Such a breakdown in reality monitoring is normally associated with major psychiatric illness, such as schizophrenia.

On occasions, people may volunteer a false confession to assist or protect the real culprit. Gudjonsson [17] highlights some evidence that confessing to crimes to protect others might be particularly common in juvenile delinquents.

Finally, Shepherd [18] identifies a subset of individuals who falsely confess to crimes to preempt further investigation of a more serious crime.

Accommodating-Compliant False Confessions

Expanding on the original three distinct categories of false confession, Shepherd recognizes a group of people for whom acquiescing with the police is more important than contradicting police assertions about what happened. In such circumstances a false confession arises from a strong need for approval and to be liked. Police conduct is noncoercive, although it does involve the use of leading questions sufficiently obvious to suggest to the suspect what answers the police want to hear. People at all intellectual levels are at risk of behaving in this manner, with those who are excessively compliant being at greatest risk.

Coerced-Compliant False Confessions

Coerced-compliant false confessions are typically elicited during persuasive interrogation: the person perceives that there is some immediate instrumental gain from confessing. The suspect does not confess voluntarily but comes to give in to the demands and pressures of the interrogators. He or she is fully aware of not having committed the crime of which he is accused, and the confession is usually retracted once the immediate threat is over.

Gudjonsson [17] suggests that the four main types of perceived immediate gain are being allowed home after confessing, bringing the interview to an end, a means of coping with the demand characteristics (including the perceived pressure) of the situation, and avoidance of being locked up in police custody.

In these circumstances the suspect may be vaguely or fully aware of the consequences of making a false self-incriminating statement, but the perceived immediate gain outweighs, in their mind, the potential long-term consequences. They may naively believe that the truth will come out later in court, perpetuating the belief shared by many police officers and legal advisers that what happens in the police station is not really that important.

Coerced-Internalized False Confessions

Coerced-internalized false confessions occur when suspects are gradually persuaded that they have committed a crime of which they have no memory recollection, or when they have become so confused that they begin to mistrust their own memory and accept a false scenario suggested by the police. This type of confession can happen under two distinct conditions:

1. The suspects have no memory of the alleged offense, even whether or not they committed it. This can be as a result of amnesia or alcohol-induced memory loss. In essence, the suspects have no clear recollection of what they were doing at the time the offense was committed and come to believe they must have committed the crime.

2. At the outset of the interview, the suspects have a clear recollection that they were not involved in the alleged offense. However, as a result of subtle manipulative techniques employed by the interrogator, they begin to distrust their own memory and beliefs. Interrogators attempt to undermine the suspects' confidence in their own recollection of events, which would create sufficient self-doubt and confusion to cause them to adjust their perceptions of reality.

In contrast to the makers of coerced-compliant false confessions, those who make coerced-internalized false confessions only come to retract when they realize, or suspect, that they are in fact innocent. These retractions can take considerable time and, on occasion, may never occur if the original memory of events becomes permanently distorted.

Suggestibility and Compliance

Of vital importance to an understanding of why false confessions can often prove so incriminating is an awareness of the theory of interrogative suggestibility [19, 20]. At the heart of the theory is the way leading questions can produce distorted responses from suspects because they are phrased in such a way as to suggest the expected response. Through this process people can come to accept a piece of post-event information and incorporate it into their memory, thus appearing to have "special knowledge" about the alleged offense. This special knowledge may seriously mislead the police and the courts to assume the suspect's guilt erroneously. Suggestibility has been found to correlate with anxiety, lack of assertiveness, poor self-esteem, and low intelligence [21].

Compliance refers to the tendency of people to obey the instructions of others when they don't really want to, either because they are overeager to please or are simply unable to resist the pressure [22]. The traits of both suggestibility and compliance have been shown to be relevant to the issue of false confessions [23].

Preventing False Confessions

It is a fundamental tenet of both American and English law that reliance should only be placed on confession evidence that is given freely and voluntarily. In considering the voluntary nature of a confession, several factors will need to be considered. These include the vulnerability of the accused (through factors such as age, mental illness and handicap, physical illness or injury, intoxication), the conditions of detention (lack of access to legal advice, failure to be given legal rights, adequate rest periods during detention), and the characteristics of the interrogation (threats, physical abuse, inducements etc.).

In America the most important legal development designed to protect the rights of suspects and deter police misconduct relates to the case of Miranda v Arizona, which was decided in 1966 [24]. The effect of this judgment was to ensure that all criminal suspects in police custody must be warned against self-incrimination and made aware of their right to remain silent and to receive legal advice. These rights have to be actively waived by the accused before interrogation can commence, and any violations of the requirements render any subsequent confession inadmissible.

In the United Kingdom, statutory safeguards are provided by the Police and Criminal Evidence Act 1984 (PACE) and the Codes of Practice set up under section 66 of this Act [25], which regulate practice in respect to a number of matters including the detention, treatment, and questioning of persons by police officers. Confessions will generally be inadmissible if the provisions of the Codes of Practice are breached by the police [26, 27].

The role of the forensic physician when assessing a suspect's fitness for interview is seen as fitting into this overall legal framework, the doctor's primary concern being to recognize any characteristics that might render the individual vulnerable to providing a false confession so that adequate safeguards can be put in place.

A Definition of Fit for Interview

Until recently there has been no clear definition of what precisely is meant by the term "fit to be interviewed," which has led to confusion among those doctors called on to perform these assessments [28]. To address this deficiency Norfolk [29] proposed a definition that was used as the starting point for discussion by a subgroup set up by the Home Office Working Party on Police Surgeons in the United Kingdom. That working party made an interim recommendation [30], which has now been modified and included since 2003 in the PACE Codes of Practice [25], thus providing the first Parliamentary approved definition of the term fitness for interview. The Codes of Practice state that:

A detainee may be at risk in an interview if it is considered that:

(a) Conducting the interview could significantly harm the detainee's physical or mental state.
(b) Anything the detainees say in the interview about their involvement or suspected involvement in the offence about which they are being interviewed might be considered unreliable in subsequent court proceedings because of their physical or mental state.

Thus, a suspect with known ischemic heart disease who is experiencing chest pain satisfies the criteria of (a) above and clearly needs assessment and appropriate treatment before it is safe to conduct an interrogation.

The concept of unreliability may be harder to evaluate and will require consideration of the various vulnerability factors associated with false confessions. In making an assessment, the Codes of Practice require the doctor to consider:

1. How the detainees' physical or mental state might affect their ability to understand the nature and purpose of the interview, to comprehend what is being asked, and to appreciate the significance of any answers given and make rational decisions about whether they want to say anything.

2. The extent to which the detainees' replies may be affected by their physical or mental condition rather than representing a rational and accurate explanation of their involvement in the offense.
3. How the nature of the interview, which could include particularly probing questions, might affect the detainees.

Scheme of Examination

When assessing a detainee's fitness for interview, the traditional medical model of taking a history and then conducting an examination should be employed. As always, informed consent should be obtained and detailed and contemporaneous notes should be taken.

The History

As much background information as is practicable should be obtained and, when possible, an indication of how long any interview is likely to take. The demand characteristics of a long interview about a suspected murder will be much greater than a short interview about a shoplifting offense.

A general medical history should be taken with enquiry made about significant illness and any prescribed medication. The detainee should be asked whether he or she has suffered from psychiatric illness, past or present, and specific enquiry should be made about alcohol and drug misuse. There should be questions about the person's educational background, as individuals with learning difficulties can be difficult to recognize and enquiring about schooling may aid identification.

Make sure the detainee has not been deprived of food or sleep and enquire about significant social distractions (e.g., a single parent may make a false confession in order to obtain early release from custody and a speedy reunion with his or her child). Detainees should be asked whether they have been detained before and if so whether they have had unpleasant experiences while in custody in the past.

The Examination

The examination should include observations on the general appearance, physical examination as appropriate, and mental state examination. A functional assessment should be performed as to whether the detainee is aware of the reason for arrest, is aware of legal rights, and is capable of making a rational decision (able to choose between relevant courses of action) and of carrying out the chosen course of action.

Each examination needs to be tailored to the individual, but doctors should be able to assess the vulnerabilities of the detainees they have been asked to examine and thus ensure that any necessary safeguards are put in place before interrogation begins.

Alcohol and Fitness for Interview

It is generally accepted that severe alcohol intoxication renders a suspect unfit to be interviewed. There is much less agreement, however, when it comes to deciding when somebody with mild or moderate intoxication should be considered fit to interview [28, 31]. The customary view that intellectual processes are impaired at lower blood alcohol levels than sensory or motor processes has been challenged. Indeed, the very opposite has been shown, with intellectual processes appearing to be more resistant to alcohol than sensory and motor skills [32]. Nonetheless, the effect alcohol can have on short-term memory should be borne in mind when advising the police on fitness. Research suggests that moderate quantities of alcohol impair the process of forming new memories [33]. Deterioration in performance of a task assessing short-term memory occurred at blood alcohol levels of 70 mg/100 mL in one study [34], and a significant impairment of eyewitness memory has been demonstrated at average blood alcohol levels of 100 mg/100 mL [35]. When suspects mistrust their own memory of events, they are at increased risk of providing coerced-internalized false confessions [17].

The ultimate decision regarding whether a suspect who has been drinking is fit for interview is best decided on the medical and functional assessment performed by the doctor rather than on arbitrarily defined "safe" blood alcohol levels [36].

Alcohol withdrawal states and the complications of alcohol withdrawal can impair cognitive functioning and affect both a suspect's ability to cope with interrogative pressure and the ability to provide reliable testimony. Even the after effects of alcohol, or "hangover," have been shown to impair critical task performance, such as aircraft operation, and can impair judgment [37]. Research evidence has also suggested that alcohol withdrawal can increase a suspect's suggestibility, although it is not totally clear whether this is a direct result of the alcohol withdrawal or a secondary effect of its treatment [38].

Substance Misuse and Fitness for Interview

A substance misuser may be rendered unfit for interview by virtue of either intoxication or withdrawal. Generally speaking, intoxication is easy to recognize, and the police will usually wait until the intoxication has cleared before starting their questioning. However, problems may be encountered with hallucinogenic substances. For example, the mental state may fluctuate in the recovery stages of an LSD experience, which may not be immediately obvious to the interrogator [39].

Withdrawal states can pose a bigger problem for the doctor assessing fitness for interview. Although most confessions made in these circumstances are reliable [40], it should be recognized that the person suffering from drug withdrawal may be particularly vulnerable to providing a false confession. Such persons may believe that compliance will result in early release and that the risks entailed in providing a false confession may seem worthwhile in the presence of an overwhelming desire to reestablish access to their supply of drugs [41].

Although symptoms of mild withdrawal from opiates, for example, is considered unlikely to be a barrier to interview [28, 39], the physical and mental distress occasioned by established withdrawal may seriously impair a suspect's fitness to undergo the somewhat threatening and difficult experience of police interrogation.

When faced with a suspect suffering from severe withdrawal, the doctor should consider advising that the interview be deferred until such time as the withdrawal has subsided or been adequately treated. If the doctor decides to treat the withdrawal state, consideration should be given to the risk that the therapeutic intervention may in itself have a bearing on fitness to interview. Arranging for therapy that the suspect has been receiving in the community to be continued in police custody is unlikely to influence fitness for interview [42, 43]. However, when substitution therapy is initiated in custody, or when symptomatic treatment alone is provided, the doctor may well need to assess the impact of the treatment before an interview takes place.

The Impact of Psychiatric Illnesses

There has been a considerable amount of research into the manner in which certain functional psychiatric illnesses can affect the reliability of testimony [44, 45]. Thus anxiety has been shown to increase a suspect's suggestibility and depression can lead to feelings of guilt and poor self-esteem that render a suspect vulnerable to providing a false confession [17]. Psychiatric illness may also render a person unfit for interview by virtue of its effect on cognitive processes or because of associated thought disorder [46, 47]. However, careful questioning that avoids the use of leading questions and coercive pressures can often elicit reliable testimony. The fact that a suspect suffers from an illness such as schizophrenia does not necessarily mean that he or she is unfit for interview [48]; such an opinion would depend on the likely demand characteristics of the interview and the functional assessment by the doctor.

Intellectual Disabilities

The police rarely have difficulty recognizing moderate or severe learning difficulties, but borderline or low-normal intelligence may not be obvious even to trained observers [49–51]. It is important to identify people with learning difficulties – questions regarding reading and writing ability and the need for special help with education can be useful – because they will be particularly vulnerable in police custody. Such individuals may have difficulties in understanding their legal rights and in communicating with police officers. They are also more likely to be suggestible and acquiescent [52].

The Effect of Physical Illnesses on Fitness for Interview

The presence of any physical illness renders an individual more vulnerable when faced with a stressful situation such as a custodial interrogation. Features such as anxiety or depression will affect a person's ability to function during the police interview, and physical illness, especially if severe, is as likely to cause anxiety and depression as any other form of stress [53]. The severity of the emotional response will depend on the nature of the illness itself, the personality of the individual and social circumstances. Suspects who are already coping with physical illness are more likely to focus on the short-term consequences of their behavior than the long-term ones, thus increasing the risk that they might provide a false confession [17].

As the impact of physical illness on a person's coping strategy is not disease specific, depending more on the actual or perceived severity of the illness rather than the nature of the illness itself, the actual diagnosis is unimportant. By contrast, there are many physical illnesses in which characteristic disturbances in cognitive functioning have been recognized [54]. With these illnesses, the nature and degree of the mental disturbance produced depends entirely on the diagnosis of the underlying condition. The more common of the conditions encountered in custody are discussed below.

Epilepsy

It is now clear, after long historical dispute, that a predisposition to epileptic fits does not mean per se that there will be associated intellectual impairment, personality disorder, or mental illness. Most epileptic patients remain mentally normal, although this does depend on the presence, site, and extent of any brain damage underlying the epilepsy [55].

However, those epileptics without significant brain damage do, nonetheless, remain prone to cognitive impairment, particularly memory impairment, as a result of their epilepsy and its treatment. The potential impact of this cognitive impairment has to be considered when assessing an epileptic suspect's fitness for interview.

For example, problems with concentration, memory, and intellectual functioning can be seen when anticonvulsant drugs are administered in toxic doses or unsuitable combinations [56]. Suspicion should be raised when a suspect complains of mental lethargy or appears to be performing below expected levels, symptoms particularly associated with toxicity.

Further problems with the reliability of testimony from epileptics may be related to their personality. Patients with epilepsy are often overprotected in childhood by concerned parents and, later in life, can be exposed to profound social and occupational discrimination [57]. All these factors can lead to personality problems, which include feelings of insecurity, low self-esteem, and dependency. Individuals with these personality traits are likely to be highly suggestible and may strive to please interviewing officers by giving answers that seem plausible and consistent with the external cues provided, even though the responses are known to be untrue.

The neurophysiologic consequences of an epileptic fit can in themselves seriously distort an individual's perception of events occurring around the time of the fit, thus rendering any subsequent account of that event potentially unreliable. Complex disturbances of thinking, memory, or awareness may feature as part of an aura preceding the actual seizure. These may include distortion of time sense, mental confusion, or feelings of depersonalization or déja vu. The fit may also be ushered in by distorted perceptions or actual hallucinations of sight, hearing, taste, or smell. When the ensuing fit is mild or abortive, the connection between these reported experiences and their epileptic causation may be missed [57].

Typical absences (or petit mal epilepsy) is a disorder that usually starts in childhood, but the attacks can continue into adult life. Absence attacks are brief, with an abrupt onset and termination; several such absences may occur in quick succession, producing significant gaps in memory.

Further cognitive disturbances can follow in the wake of seizures, with clouding of consciousness and disorientation lasting for a few minutes or up to an hour or more, so that recollection for events occurring during the postictal period may also be unreliable [55].

Head Injury

Head injuries may occur in a number of circumstances involving possible criminal offenses such as road traffic accidents and assaults; therefore, it is not uncommon to encounter head-injured detainees in police custody. The potential for the head injury to affect the person's ability to recall the details of the accident or assault can assume considerable importance.

Memory loss for events occurring around the time of the injury is likely to occur whenever there has been diffuse brain damage of a degree sufficient to cause concussion. In most cases loss of consciousness will accompany the head injury, but this is not invariable, and it is possible for patients to display both retrograde and post-traumatic amnesia without losing consciousness [54].

Retrograde amnesia refers to the loss of memory for events that immediately precede the head injury. Individuals can often indicate with fair precision the last event that they can clearly recollect. In road traffic accidents the journey may be recalled up to a specific point, which allows an estimate of the extent of the pretraumatic gap to be made. Such amnesia is usually short in duration and can usually be counted in minutes or hours rather than days or weeks. Indeed, when the retrograde amnesia lasts for a long time the explanation is often due to hysteria.

Retrograde amnesia may render a suspect unfit for interview immediately after the head injury, but the doctor should be aware that the extent of the amnesia can change with time. At first it may be very long, but it can then shrink over the next days and weeks, eventually ending up as a matter of minutes only. Recovery from retrograde amnesia tends to occur in chronological order, with items in the distant past recovering first.

By contrast, post-traumatic amnesia refers to the period from the moment of the injury until normal continuous memory returns, the length of the amnesia providing a good index, albeit in retrospect, of the severity of the brain damage [58]. It should be emphasized that the amnesia only ends when the person becomes able to give a clear and consecutive account of what is happening around him or her. Sometimes "islands of memory" will be exhibited, but these should not be taken as indicating the end of the amnesia. There is a similar danger in underestimating the duration of post-traumatic amnesia in those suspects who, although aware of things going on around them, are unable to recall these events at a later date [54].

A variety of behaviors may be exhibited during the period of post-traumatic amnesia, ranging from apparent normality to obvious confusion. In general, however, behavior is unremarkable, and the doctor may be easily misled into believing that there is nothing amiss. The individuals themselves are usually unaware of the abnormal memory at the time and can give superficial or made-up explanations for any defects that are discovered. Occasionally these false memories can appear most convincing [59].

Migraine

Migraine is a common and sometimes incapacitating disorder, affecting approximately 20% of women and 15% of men at some time in their lives [60]. Some degree of mental change is almost universal during attacks. Anxiety and irritability are common early in the attack and are often followed by drowsiness and lethargy. Cognitive impairment may occur. Cerebration is often slowed with poor concentration, and there may be marked impairment of memory [54].

Detainees who claim that they suffered an attack of migraine at or around the time of the alleged offense should be questioned closely about any cognitive impairment during previous attacks. However, it should be recognized that the pattern of any such impairment can change from attack to attack in the same person.

Hypothyroidism

A detainee who is being adequately treated for myxedema poses no particular problem for the physician assessing fitness for interview. However, an individual with undiagnosed or undertreated hypothyroidism may exhibit mental manifestations that are as important as the physical. The typical picture is of mental lethargy, general dulling of the personality, and slowing of all cognitive functions. In particular, the hypothyroid patient shows deficits in memory, abstraction, conceptual organization, and mathematical ability [61].

Diabetes Mellitus

Although confusion is a prominent feature in patients who are slipping into hyperglycemic coma, this condition is rarely seen in police custody. Questions relating to fitness for interview and the potential reliability of a detainee's confession are more likely to involve those with hypoglycemia.

Episodes of hypoglycemia are associated with irritability, anxiety, and panic in the early stages. As the episode develops, the individual becomes disinhibited and may exhibit childish or aggressive behavior that often mimics drunkenness. Disorientation and mental confusion are common and, in severe cases, the person may pass into a coma. Anybody suffering from hypoglycemia will prove to be a poor witness to events that occur during the episode. Most will have complete amnesia for the content of the attack and occasionally for an additional period before the attack occurred when their behavior will have appeared to be normal [62]. The doctor should take a clear history of any hypoglycemic episodes that may have occurred prior to arrest and should consider checking the blood sugar of any diabetic about to be interviewed by the police. The manifestations of hypoglycemia with subsequent impaired intellectual function are extremely variable, and it has been recommended that the blood sugar should be kept at 6 mmol/L or more if a diabetic person is to give a statement or be interviewed [63].

Dementia

Dementia is a large-scale problem in the elderly. It has been estimated that 5–8% of patients aged 65 suffer from dementia to an appreciable degree, with the proportion probably exceeding 20% in 80-year-olds [64]. However, in many of these patients the dementia is not recognized until there is some form of crisis in their lives. Such a crisis may be precipitated by sudden illness, bereavement, or police arrest. Individuals seem able to develop strategies to cope with their daily tasks and thus appear to function normally until the crisis disrupts the status quo and exposes the degree of their dementia [65].

Although there are many different causes of dementia, the clinical picture remains broadly similar, with any variation depending mainly on the age of onset of the illness, premorbid personality, and intelligence. In the custodial situation the doctor is likely to encounter only those at an early stage of the disease. This is characterized by impaired memory, loss of the sense of time, and spatial disorientation, all of which can distort a suspect's recollection of events. This distortion may be compounded by the lack of judgment that is frequently displayed by those with dementia and that can cause the suspect to misjudge the importance of providing reliable testimony [54]. Therefore it is important that the doctor be aware of the possibility that an elderly suspect may be suffering from dementia, even when there are reports of apparently normal social functioning prior to arrest. In such circumstances recognition of the dementia can be facilitated by using a standard test of cognitive function such as the Mini-Mental State Examination Score (see Appendix 2 of Chap. 9).

This test of cognitive function has been thoroughly validated [66]. It is called "mini" because it concentrates only on the cognitive aspects of mental functioning and excludes questions concerning mood, abnormal mental experiences, and the form of thinking. A score of 24 out of 30 was originally suggested as the lower limit of normal, but it has been repeatedly shown that performance on even this simple test is influenced very considerably by age and by educational attainment. Hence, a well-educated young adult should perform flawlessly, whereas a normal elderly subject who left school at age 14 may score as low as 22 or 23. Given this proviso, the Mini-Mental State Examination is useful in quantifying cognitive impairment and is particularly useful for grading and monitoring the severity of dementia.

Reference

1. Baldwin J, McConville M (1980) Confessions in Crown Court Trials. Royal Commission on Criminal Procedure Research Study No. 5. Her Majesty's Stationery Office, London
2. Wald M, Ayres R, Hess DW, Schantz M, Whitebread CH (1967) Interrogations in New Haven: the impact of Miranda. Yale Law J 76:1519–1614
3. R v Warickshall (1783) 1 Leach 263
4. Inbau FE, Reid JE (1967) Criminal interrogations and confessions, 2nd edn. Williams & Wilkins, Baltimore
5. Royal RF, Schutt SR (1976) Gentle art of interviewing and interrogation: a professional manual and guide. Prentice Hall, Englewood Cliffs
6. Walkley J (1987) Police interrogation. A handbook for investigators. Police Review Publication, London
7. Irving B (1980) Police Interrogation. A Case Study of Current Practice. Royal Commission on Criminal Procedure, Research Study No 2. Her Majesty's Stationery Office, London
8. Irving BL, McKenzie IK (1989) Police interrogation: the effects of the police and criminal evidence act. The Police Foundation, London
9. Pearse J, Gudjonsson GH (2003) The identification and measurement of 'oppressive' police interviewing tactics in Britain, Chapter 4. In: Gudjonsson GH (ed) The psychology of interrogations and confessions, a handbook. Wiley, Chichester
10. Leiken LS (1970) Police interrogation in Colorado: the implementation of Miranda. Denver Law J 47:1–53
11. Kennedy L (1988) 10 Rillington place. Grafton, London
12. Thomas T (1987) The confait confessions. Policing 3:214–225
13. Kee R (1989) Trial and error. The true events surrounding the convictions and trials of the guildford four and the Maguire seven. Penguin, London
14. Brandon R, Davies C (1973) Wrongful imprisonment. George Allen & Unwin, London
15. Justice (1994) Unreliable evidence? Confessions and the safety of convictions. Justice, London
16. Kassin SM, Wrightsman LS (1985) The psychology of evidence and trial procedure. Sage Publications, London
17. Gudjonsson G (1992) The psychology of interrogations. Confessions and testimony. Wiley, Chichester
18. See Wolchover D, Heaton-Armstrong A (1996) On confession evidence. Sweet & Maxwell, London, p 99
19. Gudjonsson GH, Clark NK (1986) Suggestibility in police interrogation: a social psychological model. Soc Behav 1:83–104
20. Schooler JW, Loftus EF (1986) Individual differences and experimentation: complementary approaches to interrogative suggestibility. Soc Behav 1:105–112
21. Gudjonsson G (1997) Interrogative suggestibility – can it be recognised in custody? In: Norfolk GA (ed) Fit to be interviewed by the police. Association of Police Surgeons, Harrogate
22. Gudjonsson GH (1989) Compliance in an interrogation situation: a new scale. Pers Individ Differ 10:535–540

23. Groves T (1991) Explaining false confessions. BMJ 303:1087–1088
24. Miranda v Arizona 384 US 436 (1966)
25. Police and Criminal Evidence Act 1984 (s.60 (1)(a), s.60A(1) and s.66 (1)) (2006) Codes of Practice A-G 2005 for England and Wales. Her Majesty's Stationery Office, Norwich
26. R v Kenny (1994) Crim. L. R. 284
27. R v Cox (1991) Crim.L. R. 687
28. Norfolk GA (1996) Fitness to be interviewed and the appropriate adult scheme: a survey of police surgeons' attitudes. J Clin Forensic Med 3:9–13
29. Norfolk GA (1997) 'Fitness to be interviewed' – a proposed definition and scheme of examination. Med Sci Law 37:228–234
30. Norfolk GA (1997) Fit to be interviewed – a police surgeon's perspective. In: Norfolk GA (ed) Fit to be interviewed by the police. Association of Police Surgeons, Harrogate
31. Clarke MDB (1991) Fit for interview? Police Surg 40:15–18
32. Carpenter JA (1980) Effects of alcohol on some psychological processes. A critical review with special reference to automobile driving skill. Q J Stud Alcohol 23:274–314
33. Loftus EF (1980) "Did I really say that last night?" Alcohol, marijuana and memory. Psychol Today 92:42–56
34. Carpenter JA, Ross BM (1965) Effect of alcohol on short-term memory. Q J Stud Alcohol 26:561–579
35. Yuille JC, Tollestrup PA (1990) Some effects of alcohol on eyewitness memory. J Appl Psychol 75:268–273
36. Rogers DJ, Stark MM, Howitt JB (1995) The use of an alcometer in clinical forensic practice. J Clin Forensic Med 2:177–183
37. Yesavage JA, Leirer VO (1986) Hangover effects on aircraft pilots 14 hours after alcohol ingestion: a preliminary report. Am J Psychiatry 143:1546–1550
38. Gudjonsson G, Hannesdottir K, Petursson H, Bjornsson G (2002) The effects of alcohol withdrawal on mental state, interrogative suggestibility and compliance: an experimental study. J Forensic Psychol 13:53–67
39. Faculty of Forensic and Legal Medicine and Royal College of Psychiatrists (2011) Substance misuse detainees in police custody. Guidelines for Clinical Management (Fourth edition) Report of a Medical Working Group. Royal College of Psychiatrist, London. Available http://www.fflm.ac.uk
40. Sigurdsson JF, Gudjonsson GH (1994) Alcohol and drug intoxication during police interrogation and the reasons why suspects confess to the police. Addiction 89:985–997
41. Davison SE, Forshaw DM (1993) Retracted confessions: through opiate withdrawal to a new conceptual framework. Med Sci Law 33:285–290
42. Stark MM (1994) Management of drug misusers in police custody. J R Soc Med 87:584–587
43. Zacny JP (1996) Should people taking opioids for medical reasons be allowed to work and drive? Addiction 91:1581–1584
44. Ross DF, Read JD, Toglia MP (eds) (1994) Adult eyewitness testimony. Cambridge University Press, Cambridge
45. Gudjonsson GH (1995) The vulnerabilities of mentally disordered witnesses. Med Sci Law 35:101–106
46. Bluglass R, Bowden P (1990) Principles and practice of forensic psychiatry. Churchill Livingstone, Edinburgh
47. Rix KJB (1997) Fit to be interviewed by the police? Adv Psychiatr Treat 3:33–34
48. Gudjonsson G (1995) "Fitness for interview" during police detention: a conceptual framework for forensic assessment. J Forensic Psychiatry 6:185–197
49. Halstead S (1996) Forensic psychiatry for people with learning disability. Adv Psychiatr Treat 2:76–85
50. Gudjonsson G, Clare I, Rutter S, Pearse J (1993) The Royal Commission on Criminal Justice. Persons at Risk During Interviews in Police Custody: The Identification of Vulnerabilities. Research Study No. 12. Her Majesty's Stationery Office, London
51. Lyall I, Holland AJ, Styles P (1995) Incidence of persons with a learning disability detained in police custody. A needs assessment for service development. Med Sci Law 35:61–71

52. Murphy G, Clare ICH (1998) People with learning disabilities as offenders or alleged offenders in the UK criminal justice system. J R Soc Med 91:178–182
53. Mayou RA (1987) Emotional reactions to disorders. In: Weatherall DJ, Ledingham JGG, Warrell DA (eds) Oxford textbook of medicine, 2nd edn. Oxford University Press, Oxford
54. Lishman WA (1987) Organic psychiatry. The psychological consequences of cerebral disorder, 2nd edn. Blackwell Scientific Publications, Oxford
55. Lishman WA (1996) Specific conditions giving rise to mental disorder. In: Weatherall DJ, Ledingham JGG, Warrell DA (eds) Oxford textbook of medicine, 3rd edn. Oxford University Press, Oxford
56. Williams D (1963) The psychiatry of the epileptic. Proc R Soc Med 56:707–710
57. Laidlaw J, Richens A, Chadwick D (eds) (1993) A textbook of epilepsy, 4th edn. Churchill Livingstone, Edinburgh
58. Teasdale GM (1996) Head injuries. In: Weatherall DJ, Ledingham JGG, Warrell DA (eds) Oxford textbook of medicine, 3rd edn. Oxford University Press, Oxford
59. Whitty CWM, Zangwill OL (eds) (1977) Amnesia. Butterworths, London
60. Pearce JMS (1996) Headache. In: Weatherall DJ, Ledingham JGG, Warrell DA (eds) Oxford textbook of medicine, 3rd edn. Oxford University Press, Oxford
61. Droba M, Whybrow PC (1989) Endocrine and metabolic disorders. In: Kaplan HI, Sadock BJ (eds) Comprehensive textbook of psychiatry, vol 2, 5th edn. Williams and Wilkins, Baltimore
62. Deary IJ (1993) Effects of hypoglycaemia on cognitive function. In: Frier BM, Fisher BM (eds) Hypoglycaemia and diabetes: clinical and physiological aspects. Edward Arnold, London
63. Levy D (1996) Management of diabetes in clinical forensic practice. J Clin Forensic Med 3:31–36
64. Hodges JR (1996) Dementia, introduction. In: Weatherall DJ, Ledingham JGG, Warrell DA (eds) Oxford textbook of medicine, 3rd edn. Oxford University Press, Oxford
65. Pearce J (1984) Dementia. A clinical approach. Blackwell Scientific Publications, Oxford
66. Folstein MF, Folstein SE, McHugh PR (1975) “Mini-mental state”: a practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 12:189–198

Chapter 12
Substance Misuse

Margaret M. Stark and Guy A. Norfolk

Introduction

The number of individuals passing through the criminal justice system with substance misuse problems is increasing and it is essential that healthcare professionals are aware of the current drug trends in their area and have been trained to a standard to practice competently in this field.

In the United States, there has been a well-established program of research testing the urine samples of people arrested by the police for drugs and alcohol known as the Arrestee Drug Abuse Monitoring Program (ADAM). Data from urinalyses performed in 2003 show that 67% or more of adult male arrestees had recently used at least one of the following drugs: cocaine, marijuana, opiates, methamphetamine, or phencyclidine (PCP) [1], with marijuana being the most commonly used drug followed by cocaine. The program was repeated in eight countries in early 2002 to include Australia, Chile, England and Wales, Malaysia, The Netherlands, Scotland, and the United States [2].

The Arrestee Survey is a nationally representative survey of drugs and crime among individuals arrested in England and Wales. Three cycles of self-reported drug misuse have now been collected, most recently in 2005/2006 [3] which shows that 52% of all respondents reported having taken one or more drugs in the month previous to arrest; cannabis was the most widely taken drug, with 41% having taken it in the previous month, followed by heroin and powder cocaine (13%), crack (11%), and ecstasy (8%).

Other jurisdictions collect information from an extensive range of sources in an attempt to establish patterns of drug use [4, 5].

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General Principles [6]

History and Examination

A detailed history of recent drug use including alcohol needs to be obtained to establish whether the individual is a currently dependent or a recreational user (Table 12.1). Street names of substances will vary from country to country, within regions in the same country, with the cultural background of the user, and over time. The examination should look for signs of intoxication, withdrawal, or previous drug use (Table 12.2). Baseline parameters are useful for reexamination if the detainee is kept in custody. The use of an onsite drug testing kit in police stations may be of assistance [6]; however, these tests are qualitative rather than quantitative indicating that a substance has been used rather than how much has been taken, or whether the detainee is dependent, so care is needed in the overall interpretation. Urine tests have been used [7] and, increasingly oral fluid sampling, which is considered less invasive [8, 9].

Purity of illicit substances will vary between countries and from year to year; this may be reflected in the drug history obtained, with increasing amounts ingested as drug purity diminishes. Averaged figures from the United States in 2007 [10] show purity for cocaine at 65–70%, heroin 35%, methamphetamine 40–55%, compared with the UK figures in 2009/2010 [11] of (UKBA/Police) cocaine 63/21%, heroin 53/44%, and amphetamine 26/8%. There were significant differences between the purity of drugs seized by customs and the police showing the extent to which certain drugs are cut with addition of active agents to increase the margin of any profit prior to distribution by dealers. There are two main types of impurities: substances which are psychoactive that the buyer was not expecting such as caffeine, ephedrine, paracetamol, tranquilizers such as diazepam, and substances that are completely inert such as glucose, lactose, or mannitol [12].

Harm Minimization

Information and advice should be given to the detainee by the physician on reducing the harm from continued drug misuse. Advice can be provided on a range of issues [6, 13]:

- Blood borne viruses including hepatitis B and C and human immunodeficiency virus (HIV) awareness.
- The availability of hepatitis B vaccination.
- The hazards of injecting substances and the greater safety of smoking rather than injecting.
- If the individual must inject the preference for hitting a vein rather than injecting into the muscle or skin.
- Avoidance of “shared works” such as needles, syringes, spoons, etc.
- To use different sites for injecting.

Table 12.1 Substance misuse – history

Period of regular use
The quantity used per day on a "typical" day
The frequency of use
Route of administration
The amount used in the last 24 h
Time of the last dose
Prescribed drugs
Experience of withdrawal

Table 12.2 Substance misuse – examination

Blood pressure
Pulse rate
Temperature
Pupil size
Pupillary reaction to light
Level of consciousness – lethargy/stupor/coma
Glasgow Coma Scale
Orientated in time, place, and person
Speech
Pallor
Flushed
Tremor at rest
Yawning
Lachyrmation
Rhinorrhea
Gooseflesh
Sweating
Bowel sounds
Presence of needle tracks
Content of consciousness – agitation, delirium, psychosis
Restlessness
Disordered perceptions
Coordination
Gait
Rombergs
Auscultation of the chest

- To attend for medical assistance if any pain, redness, or pus collects under the skin, at an injection site.
- Information regarding the local services involved in drug counseling and treatment can also be offered.
- Other general health problems may require treatment/referral.

Substance misusers who inject may have experienced a broken needle at some time in their injecting career [14]. Central embolization may occur within a few hours up to several days and this can lead to potentially fatal consequences including pericarditis, endocarditis, and pulmonary abscesses. Needle fragments need to be removed as soon as possible to avoid future complications. This may be done by the users themselves or necessitate attendance at the accident and emergency department.

Brief interventions, whereby it is possible to provide advice about the risks inherent in a range of patterns of substance use and to advise reducing or stopping use as part of screening and assessment [15], should be used opportunistically in the criminal justice system and have been found to be useful with alcohol consumption [16]. A person's motivation to change is important in determining the likelihood of success of any intervention [17], and such motivation may alter depending on a variety of factors. For example, negative life events such as being arrested for an acquisitive crime motivated by a need to finance a drug habit can introduce conflict in the detainee's mind about substance misuse and may increase the likelihood of successful intervention.

Arrest referral schemes are partnership initiatives set up to encourage drug misusers brought into contact with the police service to voluntarily participate in confidential help designed to address their drug-related problems. Early evaluation of such projects in the UK provides good evidence that such schemes can be effective in reducing drug use and drug-related crime [18]. In the United States it has previously been recognized that point of arrest is an appropriate stage of intervention for addressing substance misuse [19].

In 2003 a Drug Interventions Program (DIP) was introduced in the UK with the aim of identifying Class A drug (heroin and cocaine) users by testing them on charge, and directing them into drug treatment in an attempt to reduce offending behavior. In 2005 new provisions under the Drugs Act 2005 enabled testing on arrest with the implementation of "Tough Choices" – Testing on Arrest and Required Initial Assessment. This resulted in users reducing their offending and provided evidence that the criminal justice system can be an effective route for involving drug misusers in treatment and that engagement can be improved with use of semicoercive approaches such as "Tough Choices" [20].

Prescribing

Although prompt treatment to limit or prevent the withdrawal syndrome is desirable, no central nervous system (CNS) depressant medication should be given if there is evidence of intoxication with other drugs, for example, alcohol, as many substances have an additive effect. Consideration of whether the detainee is fit for detention is the priority. Most individuals are not detained in police custody for very long, and therefore medical treatment may not be required. This is particularly so if there is any question that the detainee may have recently ingested substances the full effects of which may not as yet be obvious. Reassessment after a specific period should be recommended depending on the history given by the detainee and the examination findings.

Details of medication should be verified whenever possible. It is good practice for all new substitute opiate prescriptions to be taken initially under daily supervision

[21, 22]. In the custodial situation if the detainee is on a supervised program of therapy, one can be reasonably sure the detainee is dependent on that dose; the detainee may of course be using other illicit substances as well. Recent urine test results may be checked with the clinic to see whether methadone or other drugs are detected on screening.

With opiate substitution treatment in particular, in the absence of withdrawal signs, confirmation of such treatment should be sought before authorizing continuation. The prescribed dose of opiate substitution therapy may not necessarily indicate accurately the actual amount taken each day if not supervised, as part or all of the dose may be given to other individuals. If there is doubt about the daily dose, then the dose can be divided and given every 12 h. It should be remembered that giving even a small amount of opiates to a nondependent individual may be fatal. Cocaine abuse appears to accelerate the elimination of methadone; therefore, higher doses of methadone need to be prescribed to individuals on maintenance regimes who continue to abuse cocaine [23]. Any decision to prescribe should be made on the assessment of objective signs as opposed to subjective symptoms, and a detailed record of the history and examination should be made contemporaneously. If there is any doubt as to the interpretation of the given history, findings on physical examination, and need for prescribing [24] then it is essential to seek advice from a senior colleague.

Good practice dictates that where treatment can be verified it should be continued as long as it is clinically safe to do so. Evidence from the National Treatment Outcome Research Study (NTORS), a prospective study of treatment outcome among substance misusers in the UK, has shown substantial reduction across a range of problem behaviors 4–5 years after patients were admitted to national treatment programs and it is important not to disrupt such programs [25]. Individuals referred from the criminal justice system have been found to have more complex offending patterns and chaotic problems, although a significant majority 73% have been in treatment before [26]. So it is important to facilitate reinitiation of treatment for this "difficult group."

Medical Complications of Substance Misuse

Medical complications of substance misuse may give an indication of a problem in the absence of acute symptoms or signs of intoxication or withdrawal. Intravenous injection may result in superficial thrombophlebitis, deep vein thrombosis and pulmonary embolus, and chronic complications of limb swelling and venous ulcers. If injection occurs accidentally into an artery vascular spasm may result in ischemia which, if prolonged, can lead to gangrene and amputation.

Cellulitis and abscesses may be seen around injection sites, and deep abscesses may extend into joints, producing septic arthritis. Self-neglect, malnutrition, and dental decay may occur, as may infectious diseases such as hepatitis B, C, HIV, and the acquired immunodeficiency syndrome (AIDS).

Skin manifestations of drug addiction [27] may be seen more commonly in opiate rather than stimulant users, even though stimulant users inject more frequently. This is partly because stimulants do not cause histamine release and are therefore seldom associated with pruritus and excoriations and also because cutaneous complications are frequently caused by the adulterants injected along with the opiates, rather than the drugs themselves. Fresh puncture sites, tattoos used to cover needle tracks, keloid formation, track marks from chronic inflammation, burns, ulcerated areas and skin popping resulting in atrophic scars, necrotizing fasciitis, acute generalized exanthematous pustulosis, fungal infections, hyperpigmentation at sites of healed abscess, puffy hands (lymphoedema with obliteration of anatomic landmarks and pitting edema absent), and histamine-related urticaria (opiates act on mast cells resulting in histamine release) may be seen.

Specific Drugs

The classification of drugs into their physiologic or psychological actions, e.g., stimulants and sedatives, is unsatisfactory because a single drug may have several actions; it is preferable to classify drugs according to their pharmacodynamic actions (Table 12.3) [28, 29].

Table 12.3 Drugs of misuse: how they work

Mechanism	Transmitter
Mimicking (substituting for) natural transmitters	
Opioids	Endorphin/encephalin
Alcohol	GABA-A/endorphins
Benzodiazepines	GABA-A
Cannabis	CB1 (brain) and CB2 (immune tissue)
LSD	5-HT (1, 2 receptors)
Increasing endogenous transmitter release	
Cocaine	Dopamine, noradrenaline, serotonin
Amphetamine	Dopamine, noradrenaline, serotonin
Ecstasy	Dopamine, noradrenaline, serotonin
Solvents	Noradrenaline (?)
Blocking natural transmitters	
Alcohol	Glutamate
Barbiturates	Glutamate
Ketamine	Glutamate

Adapted from Nutt [28]

GABA-A aminobutyric acid A type receptor; *5-HT* serotonin; *Glutamate* *N*-methyl-D-aspartate

Table 12.4 Medical syndromes in heroin users

Syndrome (onset and duration)	Characteristics
Opiate intoxication	Conscious, sedated "nodding"; mood normal to euphoric; pin-point pupils
Acute overdose	Unconscious; pin-point pupils; slow shallow respirations
Opiate withdrawal	
Anticipatory 3–4 h after the last fix (as acute effects of heroin subside)	Fear of withdrawal, anxiety, drug-craving, drug-seeking behavior
Early 8–10 h after last fix	Anxiety, restlessness, yawning, nausea, sweating, nasal stuffiness, rhinorrhea, lacrimation, dilated pupils, stomach cramps, increased bowel sounds, drug-seeking behavior
Fully developed 1–3 days after last fix	Severe anxiety, tremor, restlessness, piloerection (cold-turkey), vomiting, diarrhea, muscle spasms (kicking the habit), muscle pain, increased blood pressure, tachycardia, fever, chills, impulse-driven drug-seeking behavior
Protracted abstinence	Hypotension, bradycardia, insomnia, loss of energy and appetite, stimulus-driven opiate cravings

From Ling and Wesson [232]

Opiate Intoxication and Withdrawal

The characteristics of the medical syndromes in opiate intoxication, overdose, and withdrawal are given in Table 12.4. Opiates such as heroin may be taken orally, more usually injected, or smoked – "chasing the dragon." The start of withdrawal will vary in time with the different opioid drugs, and it should be remembered that the severity of withdrawal symptoms is influenced greatly by psychological factors [30]; the environment of a police cell is likely to exacerbate these symptoms.

Chronic administration of opiate drugs results in tolerance (Table 12.5) to effects such as euphoria mediated by the opiate receptors and to the effects on the autonomic nervous system mediated by the noradrenergic pathways. Tolerance to heroin can develop within 2 weeks of commencing daily heroin use, occurs more slowly with methadone, and may go as quickly as it develops. With abrupt withdrawal of opiates, there is a "noradrenergic storm," which is responsible for many of the opiate

Table 12.5 Diagnostic criteria for substance dependence

Substance dependence is a syndrome characterized by a maladaptive pattern of substance use, leading to clinically significant impairment or distress, as manifested by three (or more) of the following, occurring at any time during the same 12 month period[a]

1. Tolerance as defined by either of the following
   (a) A need for markedly increased amounts of the substance to achieve intoxication or desired effects
   (b) Markedly diminished effect with continued use of the same amount of the substance
2. Withdrawal, as manifested by either of the following
   (a) The characteristic withdrawal syndrome for the substance
   (b) The same (or closely related) substance is taken to relieve of avoid withdrawal symptoms
3. The substance is often taken in larger amounts or over longer period than was intended
4. There is a persistent desire or unsuccessful efforts to cut down or control substance use
5. A great deal of time is spent in activities necessary to obtain the substance (e.g., for opioids – shoplifting, visiting multiple doctors), use of the substance or recovering from its effects
6. Important social, occupational, or recreational activities are given up or reduced because of substance use
7. The substance use is continued despite knowledge of having a persistent or recurrent physical or psychological problem that is likely to have been caused or exacerbated by the substance (e.g., current cocaine use despite recognition of cocaine-induced depression or continued drinking despite recognition that an ulcer was made worse by alcohol consumption)

Severity of opioid dependence[b]

Mild	Few, if any symptoms are present in excess of those required to make the diagnosis, and the symptoms result in no more than mild impairment in occupational functioning or in usual social activities or relationships with others
Moderate	Functional impairment of symptoms is between mild and severe
Severe	Many symptoms are present in excess of those required to make the diagnosis, and the symptoms greatly interfere with occupational functioning or usual social activities or relationship with others
Partial remission	During the past 6 months, there has been some use of the substance and some symptoms of dependence
Full remission	During the past 6 months, either there has been no use of opioids or opioids have been used and there were no symptoms of dependence

[a]From American Psychiatric Association [211]
[b]From Ling and Wesson [232]

withdrawal symptoms (Table 12.6). Cyclizine may be taken intravenously in large doses with opiates, as it is said to enhance or prolong opioid effects, also resulting in intense stimulation, hallucinations, and seizures; tolerance and dependence on cyclizine may also result [31]. Many opiate users are also dependent on benzodiazepines and concurrent benzodiazepine withdrawal may increase the severity of opiate withdrawal [32].

Table 12.6 DSM-IV diagnostic criteria for opioid withdrawal [211]

A.	Either of the following
	(1) Cessation of (or reduction in) opioid use that has been heavy and prolonged (several weeks or longer)
	(2) Administration of an opioid antagonists after a period of opioid use
B.	Three (or more) of the following, developing within minutes to several days after Criterion A
	(1) Dysphoric mood
	(2) Nausea or vomiting
	(3) Muscle aches
	(4) Lacrimation or rhinorrhoea
	(5) Pupillary dilation, piloerection, or sweating
	(6) Diarrhea
	(7) Yawning
	(8) Fever
	(9) Insomnia
C.	The symptoms in Criterion B cause clinically significant distress or impairment in social, occupational, or other important areas of functioning
D.	The symptoms are not due to a general medical condition and are not better accounted for by another mental disorder

Treatment of Opiate Withdrawal

A careful history and thorough physical examination should be carried out to establish the nature and severity of the abstinence syndrome prior to treatment; use of a clinical opiate withdrawal scale may assist in the assessment [33, 34]. Symptomatic treatment of the opiate withdrawal syndrome can often be achieved using a combination of drugs such as benzodiazepines for anxiety and insomnia; loperamide or diphenoxylate and atropine for diarrhea; promethazine, which has anti-emetic and sedative properties; and paracetamol or nonsteroidal anti-inflammatories for generalized aches. However overall there is low efficacy of non-opioid drugs in treating opioid withdrawal with only benzodiazepines having a moderate positive effect [35]. Benzodiazepines are not recommended in the routine treatment of opiate withdrawal in this setting as such drugs may affect cognition and therefore fitness to be interviewed.

Substitution treatment may be required in more severe cases of opiate dependence using a choice of methadone, buprenorphine, or dihydrocodeine [36]. As street heroin varies in purity, the starting dose cannot be accurately estimated on the basis of the amount of street drug used. Therefore, substitution therapy should be titrated against the symptoms and signs of withdrawal. For example, dihydrocodeine may be commenced in a dose of 90–120 mg three times a day, with the dose being increased if the patient has demonstrable clinical signs of opiate withdrawal [37, 38].

Clonidine and lofexidine act as presynaptic α_2-adrenergic agonists, which inhibit the noradrenergic storm associated with opiate withdrawal. Although clonidine has been shown to be effective in reducing most symptoms of withdrawal, the drug has side effects of hypotension, sedation, and psychiatric problems, which

Table 12.7 Half-lives and observation times required after acute narcotic overdose

Opioid	Duration of action via iv route	*t* 1/2	Observation time
Methadone (Dolophine, Amidone)	May be days	15–72	24–36
Morphine	Usually 2–4 h	3	6
Heroin	Usually 2–4 h	Very short	6
Codeine	2–4 h (oral)	3	6

Taken from Roth et al. [233]
Note: Generally if a patient remains asymptomatic 6 h after the administration of naloxone they may be discharged

render it unsuitable for use in police custody. By contrast, lofexidine has been used in detoxification from opiates with fewer side effects [39].

Maternal opiate withdrawal syndrome may be life threatening for the fetus, and special care should be taken to ensure that a pregnant, opiate-dependent woman's medication is continued while she is in custody. There should be a low threshold for referral for hospital assessment, especially in the third trimester.

Buprenorphine

Buprenorphine is an opioid with mixed agonist-antagonist properties that may be abused, or used as an alternative to methadone in detoxification from opiates [40]. It is taken sublingually, and self-administration of the drug in the custodial environment must be personally supervised by the doctor who should observe the patient for 5 min to ensure that the drug has fully dissolved [41]. This is essential to prevent hoarding and further misuse [42], for example by snorting in prison. An unusual property of buprenorphine is that after chronic administration the onset of the abstinence syndrome is delayed. Heroin addicts dependent on a small dose of opiate can be transferred onto buprenorphine, which can be withdrawn fairly easily because of the delayed onset of the abstinence syndrome. However, if it is given to an individual dependent on large doses of opiates, the antagonist properties precipitate withdrawal symptoms [38].

Naloxone

Naloxone is an opioid antagonist that reverses the effects of severe intoxication (Table 12.4). The use of naloxone may precipitate withdrawal in addicted patients, but in initial doses of 0.4–0.8 mg it is relatively safe, with little risk of vomiting, seizures, hypotension, hypertension, or cardiac arrest [43]. The half-life of naloxone is shorter than that of most opiates, and therefore a period of observation in the hospital is required after administration (Table 12.7). It is recommended to give half the dose intravenously and half intramuscularly (absorption is slower and

Table 12.8 Manifestations of sedative-hypnotic drug intoxication and withdrawal

Mild	Sedation, disorientation, slurred speech, ataxia, nystagmus
Severe	Coma, hypoventilation, hypotension, hypothermia, depressed or absent corneal, gag, and deep tendon reflexes
Withdrawal	Anxiety, insomnia, irritability, agitation, anorexia, tremor, disordered perceptions, seizures

the antidotal activity prolonged); this is useful, as often individuals discharge themselves once awakened. In the prehospital environment naloxone should only be given where there is life-threatening opiate poisoning with a respiratory rate less than 8/min, a Glasgow Coma Scale less than 8, or when the airway is at risk [44]. Heroin may be taken in combination with cocaine ("snowball"), and the use of naloxone in this situation may precipitate ventricular dysrhythmias [45, 46]. Intranasal naloxone has been used in the prehospital care environment and found to be a safe and effective first line prehospital intervention in reversing the effects of an opioid overdose, avoiding fatalities, and helping to reduce the risk of needle stick injury [47, 48].

Benzodiazepines

Benzodiazepines produce physical and psychological dependence and are therefore only recommended for limited periods [49]. The drugs are commonly misused either illicitly, which usually involves high doses, or by persistent therapeutic use at a lower dose. The pharmacologic properties of the benzodiazepines are hypnotic, anxiolytic, muscle relaxant, and anticonvulsant and are produced by enhancing gamma-aminobutyric acid (GABA) transmission [50].

Manifestations of intoxication and withdrawal are given in Table 12.8. Tolerance usually develops after continuous use, slowly for those drugs that have a long half-life but more quickly for the short-acting drugs [51]. Benzodiazepines are well absorbed from the gastrointestinal tract after oral administration; food can delay the rate but not the extent of absorption.

Side effects of use include daytime drowsiness, aggravation of depression, and anterograde amnesia [52] at therapeutic doses, the risk increasing at high dosages. Amnesic effects may be associated with inappropriate behaviors and other paradoxic behavioral responses such as increased aggression, excitement, confusion, and restlessness [53, 54]. Rage reactions with violent behavior are most likely in people with a history of aggressive behavior or unstable emotional behavior. Anxiolytics lower tolerance to alcohol and in high doses produce mental confusion similar to alcohol intoxication. The interaction between alcohol and benzodiazepines results in a potentiation of the CNS effects. In general, however, they have a very high toxic-therapeutic ratio and doses 15–20 times therapeutic dose may not cause serious side effects [55].

Sudden cessation of benzodiazepines can lead to a recognized withdrawal syndrome [56] with anxiety symptoms, disordered perceptions, and major complications such as seizures and psychosis [57]. A long-acting benzodiazepine such as diazepam or chlordiazepoxide is preferable in treating symptoms of withdrawal and preventing the major complications.

Flumazenil is a specific benzodiazepine antagonist used for the reversal of benzodiazepine-induced sedation and coma. When overdosage is suspected, it can be used in patients who would otherwise need intubation and ventilation [58] but care should be taken when mixed overdoses are suspected [59]. Complications such as convulsions, dysrhythmias, heart block, and cardiac arrest suggest that its use in the prehospital environment should not be encouraged [60].

Barbiturates

Barbiturates are used in the treatment of epilepsy and for the induction of anesthesia. They became less commonly misused following the introduction of benzodiazepine drugs but may be used by polydrug users. Mild intoxication may result in slurred speech, oversedation, ataxia, and nystagmus, while severe intoxication may present with coma, absent reflexes, hypothermia, hypotension, and respiratory depression. There is a narrow margin between therapeutic dose and serious toxicity. Physical and psychological dependence occurs, and the withdrawal syndrome is similar to that of benzodiazepine withdrawal, with a greater risk of seizures. Benzodiazepines may be used to prevent the withdrawal syndrome associated with barbiturates [57].

Solvents

Volatile substance abuse (VSA) is the deliberate inhalation of fumes given off by volatile substances (solvents) to achieve intoxication and can occur at any age but is a particular problem among adolescents. Adhesives, aerosols, anesthetics, dry cleaning agents, fuel gases, nail varnish, and paint stripper are among the substances inhaled, either directly from their containers, from a plastic bag placed over the nose and mouth, from impregnated rags, or sprayed directly into the mouth.

Regular users may have nasal sores, “glue-sniffer’s rash” (perioral dermatitis), and have the odor of solvents on their breath. Acute effects begin within minutes [61] and may last 15–45 min; persistent abnormalities may occur in severe chronic abusers (Table 12.9) [62].

There has been an overall decline in deaths from VSA in the UK since 1992 [63]. Most acute direct VSA-related deaths result from cardiac dysrhythmias due to “sensitization” of the myocardium to adrenaline; deaths may also occur from

Table 12.9 Manifestations of solvent intoxication and abuse [234]

Mild	Euphoria Disinhibition Dizziness Slurred speech Lack of coordination Sneezing and coughing
Moderate	Lethargy, stupor Hallucinations Nausea, vomiting Diarrhea Nystagmus Ataxia Tremors Myalgias Paresthesia
Severe	Coma Seizures
Chronic	Cerebellar syndrome: ataxia, nystagmus, tremor (toluene) Fatigue, difficulty in concentrating Parkinsonism (toluene) Peripheral neuropathy: symmetrical, motor, mainly involving hands and feet (*n*-hexane and naphtha)

Table 12.10 Deaths from volatile substance misuse

Acute	Direct	Immediate Postponed
	Indirect	Trauma Aspiration Asphyxia Drowning
Delayed	Direct	Liver failure Renal failure Liver tumors Bone marrow depression CNS involvement

From Shepherd [64]

indirect effects or may be delayed (Table 12.10) [64]. Animal experiments confirm that myocardial sensitivity may continue for hours after the initial inhalant exposure [65]. Tolerance may develop, and psychological dependence after long-term use and a withdrawal syndrome similar to delirium tremens has been described [66].

Lysergic Acid Diethylamide

Lysergic acid diethylamide (LSD) is usually taken orally in a dose of 20–100 mg with sympathomimetic effects occurring in 5–10 min and psychological effects in 30–60 min [67]. There is a recovery period of 10–12 h where there may be periods of normal perception and cognition alternating with degrees of intoxication, which may affect fitness for interview.

Acute effects include tachycardia, hypertension, pyrexia, dilated pupils with both anisocoria (unequal size) and hippus (spasmodic rhythmical dilation and constriction), dry mouth, sweating, flushing, tremor, and hyper-reflexia. Emotional lability, euphoria and anxiety, distortion of time, visual and auditory illusions (although true hallucinations can occur), and synesthesia, with a mixing of the sensory input – "seeing" sounds or "hearing" smells – may all occur [68].

Both enjoyable and unpleasant effects, a "bad trip," may occur in a first-time user or with repeated use [69]. Five major categories of psychiatric adverse effects have been described, which include anxiety and panic attacks, self-destructive behavior, hallucinations, acute psychosis, and major depressive reactions [70]. Polydrug users may use benzodiazepines to alleviate anxiety and panic attacks.

Chronic toxic effects include a prolonged psychosis, major depressive illness, disruption of personality, and post-hallucinogen perceptual disorder (PHPD) [70] characterized by flashbacks even months or years after LSD use.

Physical dependence does not occur, and psychological dependence is uncommon and short lived. Tolerance does occur in the chronic abuser, but a few days' abstinence will restore full CNS sensitivity to the drug.

Phencyclidine

PCP, "angel dust," is usually smoked, although it can be taken orally, intravenously, or by nasal inhalation. It is commonly used as an additive to other drugs such as cannabis or LSD, and the symptoms and signs may vary greatly [71]. At low doses euphoria, relaxation, and an altered body image may occur, but at higher doses there may be agitation, bizarre behavior, and a paranoid psychosis [72]. Analgesia occurs, which may lead to self-injury. Physical effects include nystagmus (lateral and vertical), and with severe intoxication there is adrenergic stimulation with hypertension, tachycardia, flushing, hyperthermia, and cholinomimetic stimulation with sweating, hypersalivation, miosis, dystonia, ataxia, and myoclonus eventually resulting in coma, respiratory arrest, and circulatory collapse [73]. Death may also result from intoxication or from violent behavior. Chronic effects of PCP abuse include memory impairment, personality changes, and depression; however, there is probably no physical dependence.

Table 12.11 Effects of MDMA (ecstasy)

Psychological	Euphoria, heightened awareness, improved sense of communication
Neuropsychiatric	Anxiety, insomnia, depression, paranoia, confusion, panic attacks, psychosis
Chronic	Depression, drowsiness, anxiety, panic disorder, aggressive outbursts, psychosis, memory disturbance
Medical	Tachycardia, hypertension, dry throat, bruxism, trismus, sweating, pyrexia, nausea, vomiting, anorexia, loss of coordination with ataxia, dilated pupils, nystagmus, hot and cold flushes, hyperreflexia

Ecstasy (MDMA)

3,4-Methylenedioxymethamphetamine, or "ecstasy," is commonly taken in an oral dose of 75–120 mg as a recreational drug within the dance culture or "rave" scene for its central stimulant and psychedelic effects (Table 12.11) [74]. The effects last for 4–6 h with tolerance developing to the acute effects. Problems occur because of its use with other drugs for example alcohol, cocaine, and ketamine [75]. There is little evidence for long-term physical dependence on MDMA, because of the different pharmacological action of MDMA having more effect on brain serotonin and less on brain dopamine function, but some withdrawal effects such as low mood are frequent [75].

Adverse effects such as a polydipsia, hyponatremia, and catatonic stupor have been reported [76, 77] An acute rise in antidiuretic hormone (arginine vasopressin [AVP]) accompanied by a small fall in plasma sodium has been shown following the ingestion of MDMA. Therefore, in view of the risk of hyponatremia, individuals who take such drugs should avoid drinking fluid in excess of the body's requirement. This may be difficult because MDMA reduces the perception of thirst and impairs judgment [78], and people tend to overcompensate and consciously overdrink.

Regular users may habitually use chewing gum to overcome the effects on the jaw muscles. The clenching of teeth in the acidic environment caused by carbonated (fizzy) drinks will result in an increased likelihood of tooth wear on the back teeth [79]. Other adverse effects have been described including jaundice and hepatotoxicity [80]; flashbacks and psychosis [81]; pneumomediastinum [82]; urinary retention [83]; hyperthermia; coagulopathy [84]; rhabdomyolysis; and cardiovascular complications resulting in death [85–87]. MDMA differs from other stimulants, such as cocaine and amphetamines, in that it rarely causes paranoid feelings or aggression [75] although the development of chronic paranoid psychosis has been described after heavy misuse of the drug [88], and the serotonin syndrome [89] (altered mental state, hyperthermia, and autonomic dysfunction) has also been reported following MDMA ingestion [90]. With regard to chronic psychological effects, a review found small but consistent negative effects of "ecstasy" on cognitive and psychomotor function [91].

Table 12.12 Effects of cocaine and amphetamine intoxication

Initial low dose	Euphoria, insomnia, dry mouth, hyperthermia, tachycardia, hypertension, increased respiration, sweating, dilated pupils
With increasing dose	Irritability, impulsivity, aggressiveness, agitated delirium, paranoia, delusions, seizures

3,4-Methylenedioxymethamphetamine (MDEA) is an analog of MDMA with similar effects. 3,4-Methylenedioxyamphetamine (MDA) and *para*-methoxyamphetamine (PMA) may also be used as recreational drugs. Overdose may result in severe sympathetic stimulation and death [92].

Cocaine and Crack

Cocaine occurs naturally in the leaves of the coca plant Erythroxylum coca, which grows predominantly in South America. Cocaine hydrochloride is a white powder that is usually snorted but can be taken orally. Crack is prepared by mixing cocaine hydrochloride with sodium bicarbonate and water and heating it. The cocaine base precipitates out and forms small "rocks" as it cools. Crack may be smoked in a pipe or heated on foil with the vapor inhaled. Both crack and cocaine may be injected.

The onset of action and plasma half-life varies depending on the route of use, very rapidly if taken intravenously or smoked compared with when snorted. The duration of effects will also vary with route of administration [93]. Ingestion of stimulant drugs such as cocaine or amphetamine results in activation of the sympathetic nervous system with resulting euphoria followed by irritability, depression, insomnia, and paranoia (Table 12.12).

Tolerance occurs to the psychological effects of cocaine. Deaths may occur, most commonly from cardiac dysrhythmias, myocardial infarction, agitated delirium, and stroke. The hearts of cocaine users undergo a process of myocardial remodeling increasing susceptibility to sudden death [94]. Chronic effects include perforation of the nasal septum and rhinorrhea, and long-term use may result in a range of psychiatric problems and vascular diseases [95].

Cocaine produces a physical and psychological dependence, the severity of which will vary depending on the method of administration, being more severe if the drug is smoked or injected than if snorted. Dependence may result in a particular strong craving for the drug, followed by a withdrawal syndrome or "crash" with irritability, insomnia, depression, and anxiety on cessation. In conditions of police custody, the depression and inability to sleep may lead to acts of self-harm and suicide, and close supervision may be required, with consideration given to prescribing hypnotics and antidepressants.

Amphetamine and Methamphetamine

Amphetamine and methamphetamine are usually found as white powders taken nasally, orally, intravenously, or smoked. Clinical effects are similar to those of cocaine (Table 12.12), although amphetamine has a longer half-life of 10–15 h, so the duration of euphoria is longer. There is considerable interindividual variability in pharmacokinetics [96]. "Ice" is a very pure form of methamphetamine hydrochloride (98–100% pure), which is usually smoked like crack cocaine.

Tolerance occurs with long-term use and psychological dependence with a withdrawal syndrome of depression, anxiety, and sleep disturbance. "Speed runs" describe repeated use over a period of days with several grams of amphetamine used daily. At the end of the "run," the user may sleep for several days. Alcohol, sedative-hypnotic drugs, and heroin may be used to reduce the anxiety caused by amphetamine or, alternatively, amphetamine may be used to reduce the sedative effects of such drugs. At higher doses, a brief toxic psychosis may occur which resolves when the drug is stopped; however, it is also possible that methamphetamine use may result in a psychotic episode with the possibility of repeated psychotic symptoms [97].

The diversion and abuse of methylphenidate, used in the treatment of attention deficit hyperactivity disorder (ADHD), has also been reported [98].

New psychoactive substances are constantly being identified. There has been a reported increase in the use of "legal highs" such as cathinones, e.g., mephedrone [99], piperazines, e.g., benzylpiperazine [100], naphyrone (naphthylpyrovalerone), and "Ivory Wave" (desoxypipradrol/2-diphenylmethylpiperidine 2-DPMP) but if a certain level of harm is recognized these drugs are rapidly brought under legislative control.

Khat

Khat consists of the young leaves of the Catha edulis plant [101]; it is usually chewed for its stimulant effect when fresh but may be drunk as an infusion of leaves. In the UK and Australia it is sold legally (it is illegal in the United States) and is increasingly used by Somali, Yemeni, and Ethiopian communities [102–105]. The main component is cathinone, with effects similar to those of amphetamine, resulting in euphoria, increased alertness, and anorexia [106] but with less potential for inducing tolerance or toxic psychosis [107]. There may also be mood lability, anxiety, and insomnia [108].

Heavy khat consumption may result in mania-like symptoms, paranoia, and an acute schizophrenia-like psychosis, usually resolving within weeks of cessation of use [109, 110]. Although there is no specific physical withdrawal syndrome, depression, hypersomnia, and loss of energy may occur when khat use is stopped [108].

Marijuana

Marijuana is the most commonly used illicit drug in the UK (with 6.6% of 16–59-year olds having used it in the last year [111]) and the United States. It is obtained from the Cannabis sativa plant, and the principal active ingredient, accounting for the majority of effects, is delta-9-tetrahydrocannabinol (THC). There are a number of forms, including hashish (a resin), herbal cannabis (a green-colored preparation made from the leaves of the plant), and "skunk" a term used to describe a potent form of the cannabis plant with high levels of THC [112], which is grown indoors using hydroponic techniques, in nutrient-rich liquids rather than soil, under grow lights or greenhouse conditions. The onset of effects is reported as being more rapid, and the hallucinogenic properties are heightened.

Cannabis is usually smoked but can be ingested as, for example, "cannabis cookies." One "joint" typically contains 10–30 mg of THC and has an onset of action of 10–20 min with effects lasting 2–3 h [72]. Effects include [113] conjunctival injection; rise in blood pressure but also postural hypotension; an increase in heat rate; worsening asthma and increased risk of chronic bronchitis; adverse effects on reproduction; relaxation and euphoria, but occasionally panic attacks and paranoia in some users; altered perceptions of space and time; impaired learning and memory; difficulty problem solving; and loss of coordination.

Tolerance has been shown to develop to many effects of cannabis including the "high" with chronic use, and an abstinence syndrome has been described with disturbed sleep, decreased appetite, restlessness, irritability, and sweating. Withdrawal symptoms are usually mild and short-lived, although they may be more severe in heavy regular users [114] and especially in those who are heavy users of tobacco.

Cannabis increases the risk of psychosis especially in frequent users and may be responsible for transient exacerbations in psychotic features in those with significant mental illness [115]. Psychotic episodes may be precipitated by relatively small quantities of high potency cannabis [116].

Anabolic Steroids

Anabolic steroids may be taken orally or intramuscularly by body builders or other individuals who want to enhance their physical appearance. Research has shown that injections of testosterone enanthate increase muscle size and strength, especially when combined with exercise [117]. To achieve the desired effect, different steroids are taken in cycles, with rest periods in between, a regime known as "stacking," or, alternatively, increasing doses of the same steroid are taken, a so-called drug pyramid [118]. Most of the steroids sold in the UK are counterfeit rather than produced by legitimate pharmaceutical companies. Consequently, they may contain a different steroid from the one indicated on the bottle, and scant reliance can be placed on the reported dose as they may have little or no steroid in them at all [119].

General effects of anabolic steroids [120] include baldness, acne (typically affecting the shoulders and upper back), raised blood pressure and heart rate, fluid retention, and a reduction in high-density lipoprotein cholesterol. Long-term effects include an increased risk of thrombosis. Subclinical impairment of myocardial function has also been reported [121]. Gynecomastia may occur, and the prostate gland may swell, resulting in impaired micturition. Most of these effects are dose-dependent and more likely with prolonged administration.

While the drug is being taken, there is a significant reduction in testosterone production by the testes so that sperm output and quality are decreased, and a return to normal can take many months after drug use is stopped. The effect on sex drive is variable, but overall it seems that the sex drive increases at the beginning of a steroid-using cycle, and then decreases to below normal after several weeks of use. Drive may remain below normal levels even after the drug is stopped until such time as the testes start producing testosterone again. There may also be a reduction in size of the testicles [122].

In women menstrual irregularities are reported, with permanent enlargement of the clitoris. There may also be growth of facial and body hair, male pattern baldness, and decreased breast size. Abuse of sex steroids by recreational body builders may be an unrecognized cause of subfertility [123].

Liver function tests may show abnormalities that usually return to normal once the drug is stopped. Drug-induced jaundice can be caused by temporarily impaired excretory function, and peliosis hepatitis, in which the liver tissue is replaced by blood-filled cysts, may occur, as can liver tumors [124] and Wilms' tumor.

Initial use may result in stimulatory effects such as increased confidence, decreased fatigue, heightened motivation, agitation, irritability, and insomnia, which may progress to argumentative and aggressive behavior and major mood disturbances including depression, mania, and hypomania [125, 126] "Roid rage," which may be associated with violent crimes [127], seems to require a high dose of steroids over several weeks, as may occur when "stacking."

Other Body Building Drugs

Polypharmacy is common among anabolic steroid users [128]. Other drugs may be used by body builders [129] including tamoxifen to reduce or prevent gynecomastia; diuretics to counteract the fluid retention caused by anabolic steroids; thyroxine to increase the rate of metabolism, which might theoretically increase the ability of anabolic steroids to boost physical strength [130]; and beta human chorionic gonadotropin to alleviate testicular atrophy [131]. Nalbuphine (Nubain) is an opioid agonist/antagonist analgesic used for the treatment of moderate to severe pain, and dependence has been reported associated with anabolic steroid use [132].

Furthermore, there has been a case report of a 21-year-old body builder who was admitted after taking excessive amounts of insulin intravenously; apparently insulin is advertised in body building magazines as having anabolic properties [133].

The recreational use of caffeine to toxic levels has been reported in a body builder who presented with a grand mal seizure [134]. Clenbuterol, which is a sympathomimetic agonist (used as an oral bronchodilator in some European countries but not licensed for human use in the UK or the United States), is said to have an "anabolic-like" effect but at high dose may cause cardiac dysrhythmias, tremor, and serious hypokalemia [135].

Gamma-Hydroxybutyrate and Gamma-Butyrolactone

Gamma-hydroxybutyrate (GHB) is a naturally occurring substance in the human brain structurally related to GABA and may be a neurotransmitter [136]. Gamma-butyrolactone (GBL) is converted to GHB in vivo postingestion with a recent reported death in the UK [137]. GHB has been used as an anesthetic (although it has little analgesic effect), to alleviate narcolepsy, and to treat alcohol and opiate dependence [138]. There have been reports of abuse in the UK and the United States within the dance scene and gay clubs and with body builders, as it is said to promote slow-wave sleep during which growth hormone is secreted [139]. It is available as a colorless, odorless liquid, powder, or capsule taken orally, rarely injected. GHB is rapidly absorbed, with peak plasma concentrations occurring after 20–45 min following oral administration. It has a half-life of 30 min [140], and effects can last from 45 min to 8 h [141].

Initial effects include euphoria followed by profound sedation, confusion, agitation, and amnesia; nausea, vomiting, and diarrhea; ataxia, seizures, hypotonia, and tremor; vertigo and dizziness; bradycardia, hypotension, and hypothermia; coma [142]; and respiratory collapse.

There is a narrow margin between intoxication and coma [143], and the clinical effects are potentiated by use of other CNS depressant drugs such as alcohol, opiates, benzodiazepines, and neuroleptics [144]. Tolerance and physical dependence after high-dose use can develop with a withdrawal syndrome, which may include insomnia, muscular cramping, tremor, and anxiety [138]. Symptoms of withdrawal from GHB are broadly similar to those for alcohol, although of a more rapid onset, and can be treated with benzodiazepines [145]. A rapid deterioration into delirium may occur in more frequent high-dose dependent users. Withdrawal is not associated with seizures, but if suspected, hospital admission should be considered [146].

Ketamine

Ketamine is a commercially available anesthetic for intravenous and intramuscular use. Recreational use is increasing in the UK [147]. It contains analgesic properties and is available on the street in powder, tablet, and liquid form; it can be smoked or taken intranasally ("snorted"), orally, intramuscularly, or by the intravenous route [139].

The onset of effects depends on the route of administration; when taken orally, effects start within 20 min and can last up to 3 h, whereas given intravenously, effects will be seen within 30 s and last about 30 min [148]. Tolerance develops after repeated use, with a decreased duration of effect [149].

Physical effects may include a cocaine-like "rush," hypertension, dysrhythmias, nausea, and vomiting, slurred speech, nystagmus, lack of coordination, and seizures. On recovery, "emergence phenomena" may occur, with psychological dissociation or out of body (flying or floating) sensations, confusion, hallucinations, synesthesia, and depersonalization [150]. Such dissociative states may result in the individual becoming divorced from reality, and these effects, coupled with possible loss of coordination and pronounced analgesia, can result in serious accidents to users. A dose-dependent depression of respiration may occur [151], and this can be a particular problem when taken with other respiratory depressant drugs such as benzodiazepines, alcohol, or opiates occasionally resulting in death [152, 153].

Ketamine has been found to induce acute and severe impairment of working, episodic, and semantic memory when used frequently [154]; some of these effects have continued 3 days after drug ingestion [155]. Such cognitive impairment may impact on a detainee's fitness for interview. A case of ketamine dependence with discontinuation symptoms has been reported [156] as has urinary tract and renal disease with chronic ketamine use presenting with urinary frequency, urgency, and suprapubic pain [157].

Alkyl Nitrites

The alkyl nitrites are volatile yellowish clear liquids that have a distinctive sweet smell. All the nitrites have vasodilatory properties and are used as a euphoric relaxant within the dance culture and to relax the anal sphincter and enhance sexual performance. The effect of inhaling the vapor, usually from the bottle or poured onto a cloth, is instantaneous and very short-lived, resulting in a "rush," but adverse effects such as dizziness, flushing, tachycardia and palpitations, headache, cold sweats, and hypotension may occur [158, 159]. Swallowing of volatile nitrites as opposed to inhaling them may result in severe methemoglobinemia [160].

Other Drugs

The use of hallucinogenic mushrooms, which grow wild in many areas of Europe [161] and in the United States, though more commonly are cultivated, has been increasing. Mushrooms are usually eaten or made into tea. The effects due to psilocybin and psilocin are unpredictable and include nausea and panic attacks, which limit their recreational popularity.

Alcohol

Crime statistics show a clear association between heavy drinking and criminal behavior, the association being most marked in relation to violent crimes. The British Crime Survey 2007/2008 found that in nearly half (45%) of all violent incidents, victims believed offenders to be under the influence of alcohol. This figure rose to 58% in cases of attacks by people they did not know. The overall impact being that in nearly a million violent attacks in 2007–2008, the aggressors were believed to be drunk [162].

While some have confirmed the association between alcohol and crime [163, 164], a direct causal link between the two has been disputed [165]. Nonetheless, alcohol assumes an importance in clinical forensic medicine because of its link with criminal activity and by virtue of the significant role it plays in a large number of assessments regarding fitness for detention [166–168]. Accordingly, a thorough understanding of the metabolism, effects, and problems associated with alcohol is essential for any doctor practicing in this field, not least because those detainees with alcohol problems, particularly those with gross intoxication, are an extremely vulnerable group for whom police custody may be inappropriate [169].

The Metabolism of Alcohol

Ethanol, hereafter referred to as alcohol, is produced by the fermentation of sugar by yeast, a process that halts at a concentration of alcohol by volume of about 15% because of the death of yeast above these levels. As a rough guide, one measure of spirits, one glass of wine, or one half-pint of beer contain 1 unit or 8 g of alcohol. However, there is a wide variation in the alcohol content of different drinks [170], and any accurate assessment of intake must bear this in mind. In the EU there is now international agreement about the labeling of alcohol content, with the alcohol content of beverages being referred to by the percentage alcohol by volume (percent v/v) [171]. This is equivalent to the number of milliliters of pure alcohol per 100 mL of the drink. In the United States, alcoholic strengths are still measured in terms of percentage proof. U.S. proof spirit contains 50% of alcohol by volume, so to convert U.S. proof to percent v/v, one simply divides by two.

Most people who have alcohol in the body have drunk it, although it can be absorbed into the systemic circulation through the lungs (blood alcohol concentrations of up to 50 mg/100 mL have been achieved after breathing alcohol/air mixtures for several hours) [172]. Little or no alcohol is absorbed through the intact skin of adults.

Once ingested, alcohol is subsequently absorbed into the body by a process of passive diffusion that occurs across the mucosal surfaces of the gastrointestinal tract [173]. As liquids pass quickly through the mouth and esophagus, little absorption takes place until alcohol has reached the stomach. The rate of absorption is maximal in the duodenum, because its mucosa is thinner and blood supply more abundant

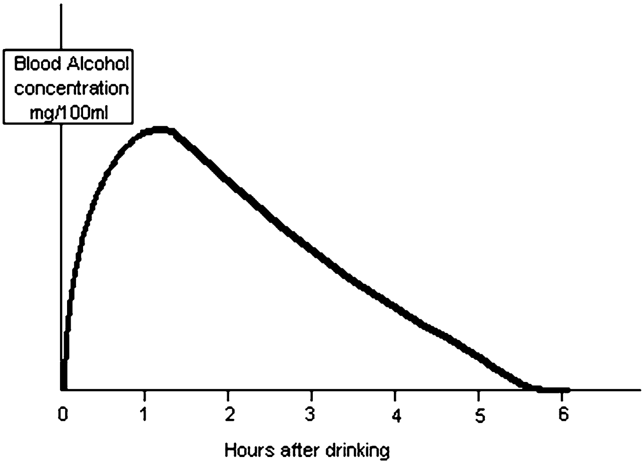

Fig. 12.1 The blood–alcohol curve

than that of the stomach. Accordingly, any condition that delivers drink into the small intestine more quickly than normal, such as gastrectomy, will lead to more rapid absorption and an earlier, higher peak blood alcohol level [174].

As soon as alcohol enters the bloodstream, mechanisms for its removal come into action. Some 5–10% of the total amount absorbed is excreted unchanged in breath, urine, and sweat [173], an important factor that allows the estimation of blood alcohol concentrations from the levels in urine and breath. The remaining 90–95% of alcohol is oxidized in the liver by alcohol dehydrogenase to form acetaldehyde, and this is further metabolized to acetate (acetic acid). As alcohol dehydrogenase becomes saturated at relatively low alcohol concentrations, it soon reaches its maximum working rate, and alcohol elimination proceeds at this constant rate [175].

The rate of absorption is very much faster than the rate of elimination, and this fact gives rise to the characteristic blood–alcohol curve, as described by several researchers (Fig. 12.1) [176–178]. Generally speaking, the peak blood alcohol concentration is reached 30–60 min after drinking, although the range may be anything from 20 min to 3 h. However, the peak blood alcohol concentration, the time taken to reach the peak, the area under the blood–alcohol curve, and the time taken to reach a zero blood alcohol level vary from person to person and within the same person over time [179]. Indeed, a large number of factors can influence the kinetics of alcohol.

Sex and Weight

Alcohol is highly hydrophilic, so once it enters the systemic circulation it is distributed evenly throughout total body water (V_d or the volume of distribution).

In general, the larger the person the larger the V_d, so that if two different sized males drink the same quantity of alcohol, a higher peak concentration will be reached in the lighter of the two because he will have a smaller V_d for the alcohol to distribute itself throughout. Similarly, because women have more body fat compared with men, and fat contains no water, higher peak alcohol levels are achieved in women than in men of the same weight. The V_d of alcohol for adult males has been shown to be about 0.70, compared with 0.60 for adult females [173].

Duration of Drinking

If a volume of alcohol is consumed over a prolonged period, it may be eliminated almost as quickly as it is absorbed, giving rise to a much lower peak alcohol concentration.

Nature of the Drink Consumed

The rate of alcohol absorption increases with the concentration of the ingested solution up until levels of between 10 and 20%, at which point absorption is maximal. Because alcohol is absorbed by passive diffusion, the rate of absorption is slower with drinks of lesser strength because of a lower concentration gradient. Furthermore, the larger volumes involved may also delay gastric emptying and further slow down absorption. By contrast, when the alcohol concentration of drinks exceeds 20% the alcohol irritates the gastric mucosa and pyloric sphincter, causing increased secretion of mucus and delayed gastric emptying, thus slowing down absorption. Carbonation of drinks may also increase the rate of absorption of alcohol although this effect does seem to be variable [180].

Food in the Stomach

Studies have shown that eating a full meal before drinking can reduce the peak alcohol level by an average of 9–23% [173, 181–183]. The presence of food in the stomach reduces the rate of gastric emptying, dilutes the alcohol that enters the stomach, and limits the contact between the alcohol and the gastric mucosa. Alcohol absorption is slowed for all these reasons.

Physiologic Factors and Genetic Variation

Factors such as stomach wall permeability, blood supply to the alimentary tract, and the rate of gastric emptying will vary from person to person, and from time to time in the same person. All of these will have a bearing on the shape of the blood–alcohol curve.

Table 12.13 Drugs that affect the rate of stomach emptying and so influence the rate of alcohol absorption

Drugs that slow gastric emptying
Drugs with anticholinergic actions, such as
Atropine
Chlorpromazine
Tricyclic antidepressants
Drugs with an adrenergic action, such as
Amphetamines
Drugs with an opioid action, such as
Antidiarrhoeal medicines
Codeine and dihydrocodeine
Diamorphine (heroin)
Methadone
Dextropropoxyphene (in co-proxamol)
Drugs that hasten stomach emptying, such as
Metoclopramide
Cisapride
Erythromycin

Adapted from Ferner [172]

Drugs

The interaction between alcohol and drugs, either prescribed or illicit, is important because so many detained persons take other drugs in conjunction with alcohol. Generally speaking, the most important interactions involve drugs altering the way a subject responds to a given amount of alcohol in the blood, for example, because the drug has CNS depressant effects that add to those of alcohol. However, a number of drugs may influence the rate of alcohol absorption by virtue of their affect on the rate of gastric emptying (Table 12.13).

Rate of Elimination

The rate of elimination of alcohol has been determined experimentally. Reported values range from about 10 mg/100 mL of blood per hour (mg/dL/h) to 25 mg/dL/h, with an average of 15–18.6 mg/dL/h [175, 184] (approximately equivalent to the elimination of 1 unit of alcohol per hour in a 70-kg male). Habituation to alcohol is the single most important factor affecting the rate of elimination. One recent study reported the rate of ethanol disappearance in 22 alcoholics as ranging from 13 to 36 mg/dL/h, with an average of 22 mg/dL/h [185]. The increased rate of elimination is thought to be because chronic alcoholics have facilitated liver enzyme systems.

Table 12.14 Sequence of central nervous depressant effects of alcohol

Stage of influence	Blood alcohol concentration (mg/100 mL)	Clinical effect
Sobriety	10–50	Often no obvious effect May feel "relaxed"
Euphoria	30–120	Mild euphoria with increased talkativeness Decreased inhibitions Increased self-confidence Impaired fine motor skills
Excitement	90–200	Emotional instability Poor sensory perception Impaired memory and comprehension Incoordination and loss of balance
Drunkenness	150–300	Disorientation, mental confusion Disturbances of vision (e.g., diplopia) Decreased pain sense Increased incoordination with staggering gait Slurred speech
Stupor	250–400	General inertia approaching paralysis Marked lack of response to stimuli Inability to stand or walk Vomiting, incontinence of urine and feces
Coma	350–500	Coma and anesthesia Depressed or absent reflexes Cardiovascular and respiratory depression Possible death
Death	Over 450	Death from respiratory depression

Effects of Alcohol

Alcohol acts as a CNS depressant, which in small doses interferes with cortical function, but which in larger doses may depress medullary processes. The apparent stimulatory effects of alcohol occur because it acts first on the so-called higher centers of the brain that govern inhibition [186].

While there is general agreement on the sequence of clinical effects caused by drinking alcohol, the blood alcohol concentrations at which these effects occur vary considerably in different subjects. The difference in susceptibility is most marked between habituated and nonhabituated drinkers, but tolerance to the effects remains very variable even within these broad categories [187, 188]. Table 12.14 provides a guide to the general effects. It should be noted that the effects are more pronounced when blood alcohol levels are rising than when falling. This is known as the Mellanby effect and is thought to be due to an acute tolerance to alcohol that develops during intoxication [189]. Some specific effects are discussed below.

Nystagmus

As the eye is effectively part of the CNS, it is one of the easiest parts of the body to examine in order to detect the effects of alcohol; the most extensively studied ocular effect of alcohol intoxication is nystagmus. Alcohol can cause nystagmus through at least two mechanisms. By acting on the vestibular system, it can cause positional alcohol nystagmus (PAN) [190], detected when the patient is lying supine with the head turned to either the left or right. Horizontal gaze nystagmus (HGN) results from the inhibition of the smooth pursuit system and the impaired ability to maintain eccentric gaze [191] brought about by alcohol's effect on ocular movements via neural mechanisms [192].

PAN occurs in two stages [193]. The first stage, PAN I, is associated with acute elevation of blood alcohol, tending to occur about 30 min after alcohol ingestion. In PAN I the fast phase of nystagmus is in the direction toward which the head is turned. PAN II normally occurs at about 5–6 h after drinking and is characterized by nystagmus in the opposite direction to that seen in PAN I.

HGN is a jerky eye movement noted when gaze is directed to one side. The fast phase of HGN is in the direction of gaze, and it becomes intensified at a more eccentric gaze position [192]. Although HGN can be seen in normal individuals at extreme lateral gaze [194], when detected at lesser deviations it is considered pathologic. An angle of onset of 40° or less from the midline has been found to be a sensitive indicator of a blood alcohol level in excess of 100 mg/100 mL [188]. While some authors have maintained that blood alcohol levels of over 80 mg/100 mL are consistently associated with HGN [195], others have found that it is absent in just under 40% of drivers with an average blood alcohol of 120 mg/100 mL (range 9–218 mg/100 mL) [196]. As HGN may be noted in a number of pathologic conditions including the ingestion of sedative and tranquilizing drugs [197], its presence should not be taken as proof of alcohol intoxication, especially as evidence in cases of driving while intoxicated (DWI) [198]. It is perhaps for these reasons that the Kansas Supreme Court, when assessing the admissibility of HGN evidence in drink driving prosecutions, decided that "the reliability of HGN evidence is not currently a settled proposition in the scientific community" [199].

Pupillary Changes

In the early stages of alcoholic intoxication, the pupils are said to dilate, often becoming pinpoint as the level of intoxication advances, particularly when the state of coma is reached [200]. However, some commentators report the pupils as being normal-sized in alcohol intoxication [201], with current advice favoring the view that pupil size may be normal or dilated [202].

Alcohol may slow the pupillary response to light, such an effect being one of the more reliable eye signs of intoxication albeit a difficult one to detect clinically [196, 203].

Slurred Speech

Speech production is a complex motor activity. As it requires a high degree of coordination, it can be a sensitive index of alcohol intoxication [204]. Reliable changes in speech are produced at blood alcohol levels above 100 mg/100 mL, although the effects of lower blood alcohol levels have been variable [205].

Cardiovascular Effects

Moderate doses of alcohol cause a slight increase in blood pressure and pulse rate [206, 207]. However, the most prominent effect with higher doses is a depression of cardiovascular functions. This depression is probably a combination of central effects and direct depression of the myocardium [189].

Metabolic Effects

Forensic physicians need to be aware that severe hypoglycemia may accompany alcohol intoxication because of inhibition of gluconeogenesis. Alcohol-induced hypoglycemia, which develops within 6–36 h of heavy drinking, typically occurs in an undernourished individual or one who has not eaten for the previous 24 h. The usual features of hypoglycemia, such as flushing, sweating, and tachycardia, are often absent, and the person may present in coma.

Death from Alcohol Poisoning

Alcohol intoxication may result in death due to respiratory or circulatory failure or as a result of aspiration of stomach contents in the absence of a gag reflex. Levels of blood alcohol above 500 mg/100 mL are considered to be "probably fatal" [208], although survival at much higher concentrations is now well documented. In 1982, for example, the case of a 24-year-old woman with a blood alcohol level of 1,510 mg/100 mL was reported. She had gone to the hospital complaining of abdominal pain and was noted to be conscious but slightly confused. Two days later her pain had eased, her blood — alcohol level fallen, and she was able to leave the hospital and return home [209].

Death associated with blood alcohol levels below 350 mg/100 mL suggests that other complicating factors are present. Most commonly this will be an interaction between alcohol and some other drug that has also been ingested.

Table 12.15 Diagnostic criteria for alcohol intoxication. DSM-IV

A. Recent ingestion of alcohol
B. Clinically significant maladaptive behavioral or psychological changes (e.g., inappropriate sexual or aggressive behavior, mood lability, impaired judgement, impaired social or occupational functioning) that developed during, or shortly after, alcohol ingestion
C. One (or more) of the following signs, developing during, or shortly after, alcohol use
   1. Slurred speech
   2. Incoordination
   3. Unsteady gait
   4. Nystagmus
   5. Impairment in attention or memory
   6. Stupor or coma
D. The symptoms are not due to a general medical condition and are not better accounted for by another mental disorder

Table 12.16 Pathological states simulating alcohol intoxication

1. Severe head injuries
2. Metabolic disorders (e.g., hypoglycemia, hyperglycemia, uremia, hyperthyroidism)
3. Neurological conditions associated with dysarthria, ataxia, tremor, drowsiness (e.g., multiple sclerosis, intracranial tumors, Parkinson's disease, epilepsy, acute vertigo)
4. The effects of drugs, either prescribed or illicit (e.g., insulin, barbiturates, benzodiazepines, cocaine)
5. Psychiatric disorders (e.g., hypomania, general paresis)
6. High fever
7. Carbon monoxide

Diagnosis of Intoxication

The terms alcohol intoxication and drunkenness are often used interchangeably. However, a distinction between these terms is justified as people may exhibit behavioral changes associated with drunkenness when they believe they have consumed alcohol but actually have not [210]. Thus the diagnostic features of alcoholic intoxication developed by the American Psychiatric Association include a requirement that there must have been recent ingestion of alcohol (Table 12.15) [211].

The fourth of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) criteria requires that medical conditions likely to account for the observed condition need to be excluded before the diagnosis of alcohol intoxication is made. This is particularly important when assessing an intoxicated detainee in police custody. Indeed, the HCP's first duty in examining such individuals should be to exclude pathologic conditions that may simulate intoxication [200] (Table 12.16), as failure to do so may lead to deaths in police custody [212]. Use of a salivary alcohol kit may assist in the management of individuals suspected of being under the influence of alcohol [213].

Alcohol Dependence

Alcohol abuse and dependence is a major risk factor for serious health, social, and economic problems [214, 215]. Early identification of those who are dependent on alcohol increases the possibility of successful treatment [216], and brief intervention by the HCP seems both feasible and acceptable [168, 217]. Although not yet validated in police custody, brief interventions have been shown to have a high acceptance among drinkers in licensed premises [218].

It is essential that custody staff ensure that those who are identified on risk assessment with an alcohol problem and/or are suspected of being dependent on alcohol should call a healthcare professional to fully assess the detainee, and whether in view of the proposed length of detention, early treatment is required to prevent the major complications of withdrawal (see below).

However, obtaining accurate and reliable information about a person's drinking habits can be extremely difficult as heavy drinkers tend to underestimate or deliberately lie about their alcohol consumption [219]. The use of an alcohol screening questionnaire (see Appendix) is essential in identifying alcohol problems [215]. The Alcohol Use Disorders Identification Test (AUDIT) identifies persons whose alcohol consumption has become harmful or hazardous to health [220] and is probably the best screening instrument in this environment [221]. Self-report questionnaires such as the MAST [222, 223] and CAGE [224, 225] may help identify those with alcohol dependency and should prevent the doctor falling into the trap of assuming that alcohol abuse is synonymous with alcohol dependence. DSM-IV distinguishes between these two diagnostic categories [211]. The main features differentiating alcohol dependence from alcohol abuse are evidence of tolerance, the presence of withdrawal symptoms, and the use of alcohol to relieve or avoid withdrawal. Treatment may be required for detainees who show signs of alcohol dependence. However, there is no need to treat those who simply abuse alcohol and who do not have a history of alcohol withdrawal.

Alcohol Withdrawal

Many alcoholics develop symptoms of withdrawal when in custody. Their acquired tolerance to, and physical dependence on, alcohol is a manifestation of compensatory neuropsychological changes that offset the drug's CNS depressant effects. When alcohol intake is abruptly stopped on incarceration, the compensatory changes give rise to signs and symptoms of withdrawal [226]. The severity of the symptoms depends mainly on the amount and duration of alcohol intake, although other factors, such as concurrent withdrawal from other drugs, like benzodiazepines, may contribute to the clinical picture [227].

Alcohol withdrawal may present as a mild picture of uncomplicated alcohol withdrawal or as the more severe syndrome of alcohol withdrawal delirium (DSM-IV criteria).

Uncomplicated Alcohol Withdrawal

This is the most frequent and benign type, usually occurring some 12–48 h after alcohol intake is reduced, although it can develop as early as 6 h after drinking has stopped. The essential features are a coarse tremor of the hands, tongue, and eyelids together with at least one of the following:

- Nausea and vomiting
- Malaise and weakness
- Autonomic hyperactivity (raised blood pressure and tachycardia)
- Anxiety, depressed mood, and irritability
- Transient hallucinations and illusions
- Headache and insomnia

If symptoms are mild it is quite safe to recommend simple observation, but there should be a low threshold for a clinical assessment by a competent HCP as tremor and agitation will usually require sedation. The drugs of choice are long-acting benzodiazepines, which will not only treat alcohol withdrawal symptoms but also prevent later complications [228]. The starting dosages depend on the severity of the withdrawal, but 20 mg of chlordiazepoxide, or 10 mg of diazepam, both given four times a day, will generally be appropriate [229].

Usually the benzodiazepines should not be started until such time as the blood alcohol level has reached zero [230]. However, detained persons with marked alcohol dependence may develop withdrawal symptoms before this point is reached. In these circumstances, it is both safe and reasonable to initiate therapy when the blood alcohol level has reached 80 mg/100 mL or thereabouts.

Consideration may need to be given to providing vitamin B compound tablets to include thiamine (vitamin B_1) to those detainees who are malnourished and who may be in custody for a prolonged period [231].

Alcohol Withdrawal Delirium

The essential diagnostic feature of this disorder is a delirium that develops after recent cessation of or reduction in alcohol consumption. Traditionally referred to as delirium tremens, this withdrawal state typically begins 72–96 h after the last drink, so it is uncommon within the normal span of detention in police custody. The delirium is characterized by impaired attention and memory, disorganized thinking, disorientation, reduced level of consciousness, perceptual disturbances, and agitation. Vivid, and often terrifying, hallucinations may occur. Usually these are visual, but other sensory modalities (e.g., auditory or tactile) may be involved. The disorder usually coexists with other features of alcohol withdrawal, for example, autonomic hyperactivity, which is usually severe.

Alcohol withdrawal delirium is a medical emergency with a mortality rate of about 5%. Once diagnosed, the detained person with delirium requires urgent hospitalization.

Complications of Alcohol Withdrawal

Several complications of alcohol withdrawal have been recognized, any one of which may be encountered when alcoholics are detained in police custody [226].

Withdrawal Seizures

Seizures are typically single and generalized. They tend to occur between 6 and 48 h after the last drink and while they are not life threatening, their importance lies in the fact that about one third of those with seizures will go on to develop alcohol withdrawal delirium.

Alcoholic Hallucinosis

This is an infrequent disorder that tends to occur at about the age of 40 in those who have been drinking heavily for more than 10 years. The essential features are vivid and persistent hallucinations, which develop shortly (usually within 48 h) after cessation of alcohol intake. The hallucinations may be auditory or visual, and their content is usually unpleasant and disturbing. The disorder may last several weeks or months and is quite different from the fleeting hallucinations observed in other forms of alcohol withdrawal.

Cardiac Arrhythmias

The frequency of tachyarrhythmias in alcohol withdrawal is high, probably because of high adrenergic nervous system activity. Sudden deaths in alcohol withdrawal are most likely due to such dysrhythmias. Adequate sedation will play a part in preventing such unwanted occurrences happening in police custody, although those with severe alcohol withdrawal are best admitted to the hospital, where they can be placed on a cardiac monitor.

Metabolic Disorders

Wernicke's encephalopathy is an acute, potentially reversible neurologic disorder that is thought to be due to a deficiency of thiamine and is often secondary to chronic alcohol abuse. Features include disturbance of consciousness (ranging from mild confusion to coma), ophthalmoplegia, nystagmus, and ataxia. The disorder has a high mortality and can lead to death within 24 h, which if untreated can progress to Korsakoff's psychosis. This is a chronic condition that usually presents as impairment of short-term memory with inability to learn new information and compensatory confabulation. Korsakoff's psychosis probably represents irreversible brain damage secondary to the combined toxicity of alcohol and metabolic derangement due to thiamine deficiency.

Appendix: Alcohol Assessment Questionnaires

The Brief MAST

Questions	Yes (Score)	No
1. Do you feel you are a normal drinker?	0	2
2. Do friends or relatives think you're a normal drinker?	0	2
3. Have you ever attended a meeting of Alcoholics Anonymous?	5	0
4. Have you ever lost boyfriends/girlfriends because of drinking?	2	0
5. Have you ever got into trouble at work because of drinking?	2	0
6. Have you ever neglected your obligations, your family or your work for more than 2 days in a row because you were drinking?	2	0
7. Have you ever had DTs, severe shaking, heard voices or seen things that weren't there after heavy drinking?	2	0
8. Have you ever gone to anyone for help about your drinking?	5	0
9. Have you ever been in hospital because of drinking?	5	0
10. Have you ever been arrested for drunk driving or driving after drinking?	2	0

The brief MAST is useful as a quick screening instrument to distinguish between alcohol dependent (a score of 6 or above) and nonalcohol dependent individuals

Pokorny et al. [222]

The CAGE Questionnaire

1. Have you ever felt you should *C*ut down on your drinking?
2. Have people *A*nnoyed you by criticising your drinking?
3. Have you ever felt bad or *G*uilty about your drinking?
4. Have you ever had a drink first thing in the morning to steady your nerves, or to get rid of a hangover (*E*ye-opener)?

Two or more positive responses sensitive indicator of alcohol dependence.

Mayfield et al. [224]

The AUDIT Questionnaire

Circle the number that comes closest to the patient's answer.

1. How often do you have a drink containing alcohol?

   (0) NEVER | (1) MONTHLY OR LESS | (2) TWO TO FOUR TIMES A MONTH | (3) TWO TO THREE TIMES A WEEK | (4) FOUR OR MORE TIMES A WEEK

2. How many drinks containing alcohol do you have on a typical day when you are drinking? (CODE NUMBER OF STANDARD DRINKS)

   (0) 1 OR 2 | (1) 3 OR 4 | (2) 5 OR 6 | (3) 7 OR 8 | (4) 10 OR MORE

3. How often do you have six or more drinks on one occasion?

   (0) NEVER | (1) LESS THAN MONTHLY | (2) MONTHLY | (3) WEEKLY | (4) DAILY OR ALMOST DAILY

4. How often during the last year have you found that you were not able to stop drinking once you had started?

   (0) NEVER | (1) LESS THAN MONTHLY | (2) MONTHLY | (3) WEEKLY | (4) DAILY OR ALMOST DAILY

5. How often during the last year have you failed to do what was normally expected from you because of drinking?

   (0) NEVER | (1) LESS THAN MONTHLY | (2) MONTHLY | (3) WEEKLY | (4) DAILY OR ALMOST DAILY

6. How often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking session?

   (0) NEVER | (1) LESS THAN MONTHLY | (2) MONTHLY | (3) WEEKLY | (4) DAILY OR ALMOST DAILY

7. How often during the last year have you had a feeling of guilt or remorse after drinking?

   (0) NEVER | (1) LESS THAN MONTHLY | (2) MONTHLY | (3) WEEKLY | (4) DAILY OR ALMOST DAILY

8. How often during the last year have you been unable to remember what happened the night before because you had been drinking?

   (0) NEVER | (1) LESS THAN MONTHLY | (2) MONTHLY | (3) WEEKLY | (4) DAILY OR ALMOST DAILY

9. Have you or someone else been injured as a result of your drinking?

   (0) NO | (2) YES, BUT NOT IN THE LAST YEAR (4) YES, DURING THE LAST YEAR

10. Has a relative or friend or a doctor or other health worker, been concerned about your drinking or suggested you cut down?

    (0) NO | (2) YES, BUT NOT IN THE LAST YEAR (4) YES, DURING THE LAST YEAR

*In determining the response categories it has been assumed that one "drink" contains 10 g alcohol. In countries where the alcohol content of a standard drink differs by more than 25% from 10 g, the response category should be modified accordingly

Record sum of individual item scores here ______

A score of 8 produces the highest sensitivity; a score of ten or more results in higher specificity. In general high scores on the first three items in the absence of elevated scores on the remaining items suggest hazardous alcohol use. Elevated scores on items 4 through 6 imply the emergence of alcohol dependence. High scores on the remaining items suggest harmful alcohol use

For details see: Babor et al. [220]

References

1. Zhang Z (2003) Drug and alcohol use and related matters among arrestees 2003. Arrestee Drug Abuse Monitoring Program (ADAM). National Institute of Justice (NIJ). www.ojp.usdoj.gov/nij/topics/drugs/adam.htm
2. National Institute of Justice (2002) I–ADAM in eight countries. Approaches and Challenges. Taylor B (ed) NCJ. http://www.ncjrs.gov/pdffiles1/nij/189768.pdf
3. Boreham R, Cronberg A, Dollin L, Pudney S (2007) The arrestee survey 2003–2006. Home Office Statistical Bulletin. www.homeoffice.gov.uk/rds. Accessed Nov 2007
4. State Government of Victoria, Australia, Department of Health (2010) Victoria drug statistics handbook. Patterns of drug use & related harm in Victoria. www.health.vic.gov.au/drugservices/pubs/drugstats.htm. Accessed 30 Oct 2010
5. Stafford J, Burns L (2010) Australian drugs trends 2009 findings from the illicit drug reporting system (IDRS) Australian Drug Trends Series No. 37 National Drug and Alcohol Research Centre, University of New South Wales, Sydney. http://www.med.unsw.edu.au/NDARCWeb.nsf/resources/DRUG_TRENDS_1_NAT/$file/DT2009.pdf
6. Faculty of Forensic and Leger Medicine and Royal College of Psychiatrists (2011) Substance misuse detainees in police custody. Guidelines for clinical management, 4th edn. Report of a Medical Working Group. Royal College of Psychiatrists, London. www.fflm.ac.uk
7. Stark MM, Norfolk GA, Rogers DJ, Payne-James JJ (2002) The validity of self-reported substance misuse amongst detained persons in police custody. J Clin Forensic Med 9:25–26
8. Drummer OH (2006) Drug testing in oral fluid. Clin Biochem Rev 27(3):147–159
9. Kacinko SL, Barnes AJ, Kim I, Moolchan ET, Wilson L, Cooper GA, Reid C, Baldwin D, Hand CW, Huestis MA (2004) Performance characteristics of the Cozart® RapiScan oral fluid drug testing system for opiates in comparison to ELISA and GC/MS following controlled codeine administration. Forensic Sci Int 141:41–48
10. Fries A, Anthony RW, Cseko A Jr, Gaither CG, Schulman E (2008) The price and purity of illicit drugs 1981–2007. Institute for Defense Analyses (IDA) for the Office of National Drug Control Policy (ONDCP). http://www.whitehousedrugpolicy.gov/publications/price_purity/price_purity07.pdf
11. Mulchandani R. Hand T. Panesar LK (2010) Seizures of drugs in England and Wales, 2009/10. Home Office Statistical Bulletin. www.homeoffice.gov.uk. Accessed 28 Oct 2010
12. Shapiro H (2009) Drug purities. Factsheet 32. Druglink 24:6. www.drugscope.org.uk
13. Nicholson F (2009) Infectious diseases and an at risk exposure. In: Stark MM, Rogers DJ, Norfolk GA (eds) Good practice guidelines for forensic medical examiners. Royal Military Police. GPG Editors, Oxford
14. Norfolk GA, Gray SF (2003) Intravenous drug users and broken needles – a hidden risk? Addiction 98:1163–1166
15. The National Institute for Health and Clinical Excellence (NICE) (2007) Drug misuse: psychosocial interventions: quick reference guide. CG51 Quick reference guide. www.nice.org.uk
16. Wallace P, Cutler S, Haines A (1988) Randomised controlled trial of general practitioner intervention in patients with excessive alcohol consumption. BMJ 297:663–668
17. Prochaska JO, Clemente CC (1984) The transtheoretical approach: crossing traditional boundaries of therapy. Dow Jones-Irwin, Homewood
18. Edmunds M, May T, Hearnden I, Hough M (1998) Arrest referral: emerging lessons from research. Home Office Drugs Prevention Initiative Paper 23. Home Office, London
19. National Institute of Justice (2003) 2000 Arrestee drug abuse monitoring: Annual Report. U.S. Department of Justice, Office of Justice Programs, Washington
20. Skodbo S, Brown G, Deacon S, Cooper A, Hall A, Millar T, Smith J, Whitham K (2007) The drug interventions programme (DIP): addressing drug use and offending though 'Tough Choices'. Home Office. www.homeoffice.org.uk/rds

21. Department of Health (England), The Scottish Government, Welsh Assembly Government and Northern Ireland Executive (2007) Drug misuse and dependence. UK guidelines on clinical management. www.dh.gov.uk/publications
22. The National Institute for Health and Clinical Excellence (NICE) (2007) Methadone and buprenorphine for the management of opioid dependence. NICE technology appraisal guidance 114. www.nice.org.uk
23. Tennant F, Shannon J (1995) Cocaine abuse in methadone maintenance patients is associated with low serum methadone concentrations. J Addict Dis 14:67–74
24. MPS (2006) Mistaken drug abuse diagnosis. Casebook vol 14, no 2, p 24. http://www.medicalprotection.org/uk/education-publications/casebook/
25. Gossop M, Marsden J, Stewart D, Kidd T (2003) The National Treatment Outcome Research Study (NTORS): 4–5 year follow-up results. Addiction 98:291–303
26. Jones A, Weston S, Moody A, Millar T, Dollin L, Anderson T, Donmall M (2007) The drug treatment outcomes research study (DTORS). Home Office. www.homeoffice.gov.uk/rds
27. Karch SB (2009) Medical consequences of opiate abuse. In: Karch's pathology of drug abuse. CRC Press, Boca Raton, pp 498–506
28. Nutt DJ (1996) Addiction: brain mechanisms and their treatment implications. Lancet 347:31–36
29. McGavock H (2005) How drugs work. Basic pharmacology for healthcare professionals, 2nd edn. Radcliffe, Oxford, pp 112–113
30. Phillips GT, Gossop M, Bradley B (1986) The influence of psychological factors on opiate withdrawal syndrome. Br J Psychiatry 149:235–238
31. Ruben SM, McLean PC, Melville J (1989) Cyclizine abuse among a group of opiate dependents receiving methadone. Br J Addict 84:929–934
32. De Wet CJ, Reed LJ, Glasper A, Moran P, Bearn J, Gossop M (2004) Benzodiazepine co-dependence exacerbates the opiate withdrawal syndrome. SSA Symposium Abstracts. Addict Biol 9(1):100
33. Wesson DR, Ling W (2003) The Clinical Opiate Withdrawal Scale (COWS). J Psychoactive Drugs 35(2):253–259
34. Tompkins DA, Bigelow GE, Harrison JA, Johnson RE, Fudala PJ, Strain EC (2009) (2009) Concurrent validation of the Clinical Opiate Withdrawal Scale (COWS) and single-item indices against the Clinical Institute Narcotic Assessment (CINA) opioid withdrawal instrument. Drug Alcohol Depend 105:154–159
35. Hermann D, Klages E, Welzel H, Mann K, Croissant B (2005) Low efficacy of non-opioid drugs in opioid withdrawal symptoms. Addict Biol 10:165–169
36. Robertson JR, Raab G, Bruce M, McKenzie JS, Storkey HR (2006) Addressing the efficacy of dihydrocodeine versus methadone as an alternative maintenance treatment for opiate dependence: a randomized controlled trial. Addiction 101:1752–1759
37. Stark MM, Gregory M (2005) The clinical management of substance misusers in police custody – a survey of current practice. J Clin Forensic Med 12:199–204
38. Ghodse H (ed) (2002) Drugs of abuse and dependence. In: Drugs and addictive behaviour – a guide to treatment. Cambridge University Press, Cambridge
39. Washton AM, Resnick RB, Geyer G (1983) Opiate withdrawal using lofexidine, a clonidine analogue with few side effects. J Clin Psychiatry 44:335–337
40. Ford C, Morton S, Lintzeris N, Bury J, Gerada C (2003) Guidance for the use of buprenorphine for the treatment of opioid dependence in primary care. Royal College of General Practitioners, London
41. Stark MM (2009) Substance misuse. In: Stark MM, Rogers DJ, Norfolk GA (eds) Good practice guidelines for forensic medical examiners. Royal Military Police. GPG Editors, Oxford
42. Tompkins CNE, Wright NMJ, Waterman MG, Sheard L (2009) Exploring prison buprenorphine misuse in the United Kingdom: a qualitative study of former prisoners. Int J Prison Health 5(2):71–87
43. Yealy DM, Paris PM, Kaplan RM, Heller MB, Marini SE (1990) The safety of prehospital naloxone administration by paramedics. Ann Emerg Med 19:902–905
44. Jones AL (1998) Initial management of poisoned patients in the out-of-hospital environment. Prehospital Immed Care 2:141–149

45. Merigian KS (1993) Cocaine-induced ventricular arrhythmias and rapid atrial fibrillation temporarily related to naloxone administration. Am J Emerg Med 11:96–97
46. Hunter R (2005) Ventricular tachycardia following naloxone administration in an illicit drug misuser. J Clin Forensic Med 12:218–219
47. Ashton H, Hassan Z (2006) Intranasal naloxone in suspected opioid overdose. Emerg Med J 23:221–223
48. Doe-Simkins M, Alexander Y, Walley AY, Epstein A, Moyer P (2009) Saved by the nose: bystander-administered intranasal naloxone hydrochloride for opioid overdose. Am J Public Health 99:788–791
49. Ashton H (1994) Guidelines for the rational use of benzodiazepines. When and what to use. Drugs 48:25–40
50. Cowen PJ, Nutt DJ (1982) Abstinence symptoms after withdrawal of tranquillising drugs. Is there a common neurochemical mechanism? Lancet ii:360–362
51. Bezchlibnyk-Butler KZ, Jeffries JJ (1996) Clinical handbook of psychotropic drugs. Hogrefe & Huber, Toronto
52. Vgontzas AN, Kales A, Bixler EO (1995) Benzodiazepine side effects: role of pharmacokinetics and pharmacodynamics. Pharmacology 51:205–223
53. Anon (1975) Editorial. Tranquillisers causing aggression. BMJ 1:113–114
54. Gordon EB (1975) Tranquillisers causing aggression. BMJ 2:36–37
55. Zevin S, Benowitz NL (1998) Drug-related syndromes. In: Karch SB (ed) Drug abuse handbook. CRC Press, Boca Raton, pp 559–560
56. Ashton H (1984) Benzodiazepine withdrawal: an unfinished story. BMJ 288:1135–1140
57. Petursson H (1994) The benzodiazepine withdrawal syndrome. Addiction 89:1455–1459
58. Roald OK, Dahl V (1989) Flunitrazepam intoxication in a child successfully treated with the benzodiazepine antagonist flumazenil. Crit Care Med 17:1355–1356
59. Hojer J, Baehrendtz S, Matell G, Gustafsson LL (1990) Diagnostic utility of flumazenil in coma with suspected poisoning: a double blind randomised controlled study. BMJ 301:1308–1311
60. Katz Y, Boulos M, Singer P, Rosenberg B (1992) Cardiac arrest associated with Flumazenil. BMJ 304:1415
61. Al-Alousi LM (1989) Pathology of volatile substance abuse: a case report and a literature review. Med Sci Law 29:189–208
62. Ron MA (1986) Volatile substance abuse: a review of possible long-term neurological, intellectual and psychiatric sequelae. Br J Psychiatry 148:235–246
63. Ghodse H, Ahmed K, Corkery J, Naidoo V, Schifano F (2010) Trends in UK deaths associated with abuse of volatile substances 1971–2008. Report 23. Volatile Substance Abuse (VSA) Mortality Project. International Centre for Drug Policy (ICDP) St George's University of London, UK
64. Shepherd RT (1989) Mechanism of sudden death associated with volatile substance abuse. Hum Toxicol 8:287–292
65. Taylor GJ, Harris WS (1970) Cardiac toxicity of aerosol propellants. JAMA 214:81–85
66. Merry J, Zachariadis N (1962) Addiction to glue sniffing. BMJ 2:1448
67. Leikin JB, Krantz AJ, Zell-Kanter M, Barkin RL, Hryhorczuk DO (1989) Clinical features and management of intoxication due to hallucinogenic drugs. Med Toxicol Adverse Drug Exp 4:324–350
68. Hollister LE, Hartman AM (1962) Mescaline, lysergic acid diethylamide and psilocybin: comparison of clinical syndromes, effects on color perception and biochemical measures. Compr Psychiatry 3:235–241
69. Abraham HD, Aldridge AM (1993) Adverse consequences of lysergic acid diethylamide. Addiction 88:1327–1334
70. Schwartz RH (1995) LSD. Its rise, fall and renewed popularity among high school students. Pediatr Clin North Am 42:403–413
71. McCarron MM, Schulze BW, Thompson GA, Conder MC, Goetz WA (1981) Acute phencyclidine intoxication: clinical patterns, complications and treatment. Ann Emerg Med 10:290–297

72. Brust JC (1993) Other agents. Phencyclidine, marijuana, hallucinogens, inhalants and anticholinergics. Neurol Clin 11:555–561
73. Aniline O, Pitts FN Jr (1982) Phencyclidine (PCP): a review and perspectives. Crit Rev Toxicol 10:145–177
74. Steele TD, McCann UD, Ricaurte GA (1994) 3,4-Methylenedioxymethamphetamine (MDMA, "ecstasy"): pharmacology and toxicology in animals and humans. Addiction 89:539–551
75. Advisory Council on the Misuse of Drugs (2008) MDMA ('ecstasy'): a review of its harms and classification under The Misuse of Drugs Act 1971. ACMD, Home Office
76. Maxwell DL, Polkey MI, Henry JA (1993) Hyponatraemia and catatonic stupor after taking "ecstasy.". BMJ 307:1399
77. Kessel B (1994) Hyponatraemia after ingestion of "ecstasy". BMJ 308:414
78. Henry JA, Fallon JK, Kicman AT, Hutt AJ, Cowan DA, Forsling M (1998) Low-dose MDMA ("ecstasy") induces vasopressin secretion. Lancet 351:1784
79. Redfearn PJ, Agrawal N, Mair LH (1998) An association between the regular use of 3,4, methylenedioxy-methamphetamine (ecstasy) and excessive wear of the teeth. Addiction 93:745–748
80. Shearman JD, Chapman RWG, Satsangi J, Ryley NG (1992) Misuse of ecstasy. BMJ 305:309
81. Creighton FJ, Black DL, Hyde CE (1991) "Ecstasy" psychosis and flashbacks. Br J Psychiatry 159:713–715
82. Levine AJ, Drew S, Rees GM (1993) "Ecstasy" induced pneumomediastinum. J R Soc Med 86:232–233
83. Bryden AA, Rothwell PJN, O'Reilly PH (1995) Urinary retention with misuse of "ecstasy". BMJ 310:504
84. Chadwick IS, Curry PD, Linsley A, Freemont AJ, Doran B (1991) Ecstasy, 3–4 methylenedioxymethamphetamine (MDMA), a fatality associated with coagulopathy and hyperthermia. J R Soc Med 84:371
85. Brown C, Osterloh J (1987) Multiple severe complications from recreational ingestion of MDMA ("ecstasy"). JAMA 258:780–781
86. Dowling GP, McDonough ET, Bost RO (1987) "Eve" and "ecstasy". A report of five deaths associated with the use of MDEA and MDMA. JAMA 257:1615–1617
87. Campkin NTA, Davies UM (1992) Another death from Ecstasy. J R Soc Med 85:61
88. McGuire P, Fahy T (1991) Chronic paranoid psychosis after misuse of MDMA (ecstasy). BMJ 302:697
89. Sternbach H (1991) The serotonin syndrome. Am J Psychiatry 148:705–713
90. Mueller PD, Korey WS (1998) Death by "ecstasy": the serotonin syndrome? Ann Emerg Med 32:377–380
91. Rogers G, Elston J, Garside R, Roome C, Taylor R, Younger P, Zawada A, Somerville M (2009) The harmful effects of recreational ecstasy: a systematic review of observational evidence. Health Technol Assess 13(6). http://www.hta.ac.uk/pdfexecs/summ1306.pdf
92. James RA, Dinan A (1998) Hyperpyrexia associated with fatal paramethoxyamphetamine (PMA) abuse. Med Sci Law 38:83–85
93. Resnick RB, Kestenbaum RS, Schwartz LK (1977) Acute systemic effects of cocaine in man – a controlled study by intranasal and intravenous routes. Science 195:696–698
94. Karch SB (ed) (2009) Cocaine. In: Karch's pathology of drug abuse. CRC Press, Boca Raton
95. Karch SB (ed) (2002) Cocaine. In: The pathology of drug abuse. CRC Press, Boca Raton, pp 91–120
96. Cruickshank CC, Dyer KR (2009) A review of the clinical pharmacology of methamphetamine. Addiction 104:1085–1099
97. Australian National Council on Drugs (2010) Methamphetamine. Position paper. www.ancd.org.au. Accessed 11 Feb 2010
98. Sumnall HR, Woolfall K, Cole J, Mackridge A, McVeigh J (2008) Diversion and abuse of methylphenidate. BMJ 337:1011
99. Advisory Council on the Misuse of Drugs (ACMD) (2010) Consideration of the cathinones. ACMD, London

100. Advisory Council on the Misuse of Drugs (ACMD) (2008) Control of 1-benxylpiperazine (BZP) and related compounds. ACMD, London
101. Advisory Council on the Misuse of Drugs (ACMD) (2005) Khat (Qat): assessment of risk to the individual and communities in the UK. ACMD, London
102. Griffiths P, Gossop M, Wickenden S, Dunworth J, Harris K, Lloyd C (1997) A transcultural pattern of drug use: qat (khat) in the UK. Br J Psychiatry 170:281–284
103. Ahmed AG, Salib E (1998) The Khat users: a study of khat chewing in Liverpool's Somali men. Med Sci Law 38:165–169
104. Sykes W, Coleman N, Desai P, Groom C, Gure M, Howarth R (2010) Perceptions of the social harms associated with khat use. Research Report 44, Home Office
105. Fitzgerald J (2009) Khat: a literature review. Louise Lawrence Pty Ltd. http://www.ceh.org.au/downloads/Khat_report_FINAL.pdf
106. Joyce H (1994) Khat. J Forensic Psychiatry 5:228–231
107. Al-Hebshi NN, Shaug N (2005) Khat (Catha edulis) – an updated review. Addict Biol 10:299–307
108. Luqman W, Danowski TS (1976) The use of khat (Catha edulis) in Yemen. Social and medical observations. Ann Intern Med 85:246–249
109. Yousef G, Huq Z, Lambert T (1995) Khat chewing as a cause of psychosis. Br J Hosp Med 54:322–326
110. Pantelis C, Hindler CG, Taylor JC (1989) Use and abuse of khat (Catha edulis): a review of the distribution, pharmacology, side effects, and a description of psychosis arributed to khat chewing. Psychol Med 19:657–658
111. Hoare J, Moon D (eds) (2010) Drug misuse declared: findings from the 2009/10 British Crime Survey England and Wales. Home Office Statistical Bulletin, July 2010. www.homeoffice.gov.uk/rds
112. Cohen J, Hayes G (2002) Drug notes: 3 cannabis. Drugscope, London
113. Advisory Council on the Misuse of Drugs (2008) Cannabis: classification and public health. ACMD, Home Office, London
114. Stephens RS, Roffman RA, Simpson EE (1993) Adult marijuana users seeking treatment. J Consult Clin Psychol 61:1100–1104
115. Moore THM, Zammit S, Lingford-Hughes A, Barnes TRE, Jones PB, Burke M, Lewis G (2007) Cannabis use and risk of psychotic or affective mental health outcomes: a systematic review. Lancet 370:319–328
116. Wylie AS, Scott RTA, Burnett SJ (1995) Psychosis due to "skunk". BMJ 311:125
117. Bhasin S, Storer TW, Berman N, Callegari C, Clevenger B, Phillips J et al (1996) The effects of superphysiologic doses of testosterone on muscle size and strength in normal men. N Engl J Med 335:1–7
118. Kennedy M (1990) Athletes, drugs and adverse reactions. Adverse Drug React Bull 143:536–539
119. ISDD (1996) Drug notes 9: anabolic steroids. ISDD, London
120. Haupt HA, Rovere GD (1984) Anabolic steroids: a review of the literature. Am J Sports Med 12:469–484
121. D'Andrea A, Pio C, Salerno G, Scarafile R, De Corato G, Mita C et al (2007) Left ventricular early myocardial dysfunction after chronic misuse of anabolic androgenic steroids: a Doppler myocardial and strain imaging analysis. Br J Sports Med 41:149–155
122. Stanley A, Ward M (1994) Anabolic steroids – the drugs that give and take away manhood. A case with an unusual physical sign. Med Sci Law 34:82–83
123. Lloyd FH, Powell P, Murdoch AP (1996) Anabolic steroid abuse by body builders and male subfertility. BMJ 313:100–101
124. Creagh TM, Rubin A, Evans DJ (1988) Hepatic tumours induced by anabolic steroids in an athlete. J Clin Pathol 41:441–443
125. Su T, Pagliaro M, Schmidt PJ, Pickar D, Wolkowitz O, Rubinow DR (1993) Neuropsychiatric effects of anabolic steroids in male normal volunteers. JAMA 269:2760–2764
126. Pope HG, Katz DL (1994) Psychiatric and medical effects of anabolic-androgenic steroid use. Arch Gen Psychiatry 51:375–382

127. Corrigan B (1996) Anabolic steroids and the mind. Med J Aust 165:222–226
128. Baker JS, Graham M, Davies B (2006) Gym users and abuse of prescription drugs. J R Soc Med 99:331–332
129. British Medical Association (2002) Drugs in sport. The pressure to perform. BMA, London
130. Perry HM, Wright D, Littlepage BNC (1992) Dying to be big: a review of anabolic steroid use. Br J Sports Med 26:259–261
131. Littlepage BNC, Perry HM (1993) Misusing anabolic drugs: possibilities for future policies. Addiction 88:1469–1471
132. McBride AJ, Williamson K, Petersen T (1996) Three cases of nalbuphine hydrochloride dependence associated with anabolic steroid use. Br J Sports Med 30:69–70
133. Elkin SL, Brady S, Williams IP (1997) Bodybuilders find it easy to obtain insulin to help them in training. BMJ 314:1280
134. FitzSimmons CR, Kidner N (1998) Caffeine toxicity in a bodybuilder. J Accid Emerg Med 15:196–1970
135. Perry HM, Littlepage BNC (1992) Misusing anabolic drugs. BMJ 305:1241–1242
136. Roth RH, Giarman NJ (1970) Natural occurrence of gamma-hydroxybutyrate in mammalian brain. Biochem Pharmacol 19:1087–1093
137. Dargan PI, Button J, Davies S, Ramsey J, George S, Holt D, Wood DM (2009) The first reported UK fatality related to gamma-butyolactone (GBL) ingestion. J R Soc Med 102:545–547
138. Galloway GP, Frederick SL, Staggers FE Jr, Gonzales M, Stalcup SA, Smith DE (1997) Gamma-hydroxybutyrate: an emerging drug of abuse that causes physical dependence. Addiction 92:89–96
139. Cohen J (2002) Drug notes: 9 poppers, ketamine & GHB. Drugscope, London
140. Ferrara SD, Zotti S, Tedeshi L, Frison G, Castagna F, Gallimberti L et al (1992) Pharmacokinetics of gamma-hydroxybutyric acid in alcohol dependent patients after single and repeated oral doses. Br J Clin Pharmacol 34:231–235
141. Luby S, Jones J, Zalewski A (1992) GHB use in South Carolina. Am J Public Health 82:128
142. Thomas G, Bonner S, Gascoigne A (1997) Coma induced by abuse of gamma-hydroxybutyrate: a case report. BMJ 314:35–36
143. Dyer JE (1997) ER admission cases discussed, in getting the scoop on GHB: The new recreational drug. Presented at the 49th Annual Meeting of the American Academy of Forensic Sciences, New York
144. Dyer JE, Kreutzer R, Quatrrone A, Kizer KW, Geller RJ, Smith JD et al (1991) Multistate outbreak of poisonings associated with the illicit use of gammahydroxybutyrate. JAMA 265:447–448
145. McDonagh M, Kennedy N, Glasper A, Bearn J (2004) Clinical features and management of gammahydroxybutyrate (GHB) withdrawal: a review. Drug Alcohol Depend 75:3–9
146. McDonough M, Glasper A, Bearn J (2003) Managing gamma hydroxybutyrate or "liquid ecstasy" withdrawal – meta-analysis of published cases and reporting early experience in the UK. SSA Symposium Abstracts. Addict Biol. 8(2):241–242
147. Corner L (2009) K MART, Druglink 4–7 January/February 2009
148. Jansen KL (1993) Non-medical use of ketamine. BMJ 306:601–602
149. Slogoff S, Allen GW, Wessels JV (1974) Clinical experience with subanaesthetic ketamine. Anesth Analg 53:354–358
150. White PF, Way WL, Trevor AJ (1982) Ketamine: its pharmacology and therapeutic uses. Anaethesiology 56:119–136
151. Compendium M (2002) Ketalar. Datapharm Publications, London
152. Moore KA, Kilbane EM, Jones R, Kunsman GW, Levine B, Smith M (1997) Tissue distribution of ketamine in a mixed drug fatality. J Forensic Sci 2:1183–1185
153. Gill JR, Stajic M (2000) Ketamine in non-hospital and hospital deaths in New York City. J Forensic Sci 45(3):655–658
154. Morgan CJA, Muetzelfeldt L, Curran HV (2009) Ketamine use, cognition and psychological wellbeing: a comparison of frequent, infrequent and ex-users with polydrug and non-using controls. Addiction 104:77–87

155. Curran HV, Morgan C (2000) Cognitive, dissociative and psychogenic effects of ketamine in recreational users on the night of drug use and 3 days later. Addiction 95(4):576–590
156. Critchlow DG (2006) A case of ketamine dependence with discontinuation symptoms. Addiction 101:1212–1213
157. Cottrell AM, Athreeres R, Weinstock P, Warren K, Gillatt D (2008) Urinary tract disease associated with chronic ketamine use. BMJ 336:973
158. Sigell LT, Kapp FT, Fusaro GA, Nelson ED, Falck RS (1978) Popping and snorting volatile nitrites: a current fad for getting high. Am J Psychiatry 135:1216–1218
159. Schwartz RH, Peary P (1986) Abuse of isobutyl nitrite inhalation (rush) by adolescents. Clin Pediatr 25:308–310
160. Stambach T, Haire K, Soni N, Booth J (1997) Saturday night blue – a case of near fatal poisoning from the abuse of amyl nitrite. J Accid Emerg Med 14:339–340
161. European Monitoring Centre for Drugs and Drug Addiction (2006) Thematic papers – hallucinogenic mushrooms: an emerging trend case study. EMCDDA. http://www.emcdda.europa.eu
162. Kershaw C, Nicholas S, Walker A (2008) Crime in England and Wales 2007/08. Findings from the British Crime Survey and police recorded crime. Home Office, London
163. Magennis P, Shepherd J, Hutchison I, Brown A (1998) Trends in facial injury. BMJ 316:325–326
164. The All Party Group on Alcohol Abuse (1995) Alcohol and crime: breaking the link. Alcohol Concern, London
165. Sumner M, Parker H (1995) Low in alcohol. A review of international research into alcohol's role in crime causation. The Portman Group, London
166. Moore MR, Moore SR (1994) The potential for the use of personal computers in clinical forensic medicine. J Clin Forensic Med 1:139–143
167. Robertson G (1992) The Role of Police Surgeons. The Royal Commission on Criminal Justice. Research Study No 6. HMSO, London
168. Payne-James JJ, Keys DW, Wall I, Jerreat PG, Dean PJ (1997) Alcohol misuse in clinical forensic medicine. J Clin Forensic Med 4:17–19
169. Best D, Kefas A (2004) The role of alcohol in police-related deaths. Analysis of deaths in custody (Category 3) between 2000 and 2001. Police Complaints Authority, London
170. Stockwell T, Stirling L (1989) Estimating alcohol content of drinks: common errors in applying the unit system. BMJ 298:571–572
171. EEC Directive 766/1976
172. Ferner RE (1996) Forensic pharmacology. Medicines, mayhem, and malpractice. Oxford University Press, Oxford
173. Baselt RC (1996) Disposition of alcohol in man. In: Garriott JC (ed) Medicolegal aspects of alcohol, 3rd edn. Lawyers & Judges, Tucson
174. Stark MM, Norfolk GA (2009) Substance misuse. In: McLay WDS (ed) Clinical forensic medicine, 3rd edn. Cambridge University Press, Cambridge
175. Holford NHG (1987) Clinical pharmacokinetics of ethanol. Clin Pharmacokinet 13:273–292
176. Wilkinson PK, Sedman AJ, Sakmar E, Earhart RH, Kay DR, Wagner JG (1977) Pharmacokinetics of ethanol after oral administration in the fasting state. J Pharmacokinet Biopharm 5:207–224
177. Jones AW (1996) Biochemistry and physiology of alcohol: applications to forensic science and toxicology. In: Garriott JC (ed) Medicolegal aspects of alcohol, 3rd edn. Lawyers & Judges, Tucson
178. Drew GC, Colquhoun WP, Long HA (1959) Effect of small doses of alcohol on a skill resembling driving. Medical Research Council Memorandum No. 38. HMSO, London
179. Jones AW, Jonsson KA (1994) Between-subject and within-subject variations in the pharmacokinetics of ethanol. Br J Clin Pharmacol 37:427–431
180. Roberts C, Robinson SP (2007) Alcohol concentration and carbonation of drinks. The effect on blood alcohol levels. J Forensic Leg Med 14:398–405
181. Schultz J, Weiner H, Westcott J (1980) Retardation of ethanol absorption by food in the stomach. J Stud Alcohol 41:861–870

182. Sedman AJ, Wilkinson PK, Sakmar E, Weidler DJ, Wagner JG (1976) Food effects on absorption and elimination of alcohol. J Stud Alcohol 37:1197–1214
183. Jones AW, Jonsson KA (1994) Food-induced lowering of blood-ethanol profiles and increased rate of elimination immediately after a meal. J Forensic Sci 39:1084–1093
184. Walls H, Brownlie AR (1985) Drink, drugs & driving, 2nd edn. Sweet & Maxwell, London
185. Jones AW, Sternebring B (1992) Kinetics of ethanol and methanol in alcoholics during detoxification. Alcohol Alcohol 27:641–647
186. Manno JE, Manno BR (1996) Experimental basis of alcohol-induced psychomotor performance impairment. In: Garriot JC (ed) Medicolegal aspects of alcohol, 3rd edn. Lawyers & Judges, Tucson
187. Urso T, Gavaler JS, Van Thiel DH (1981) Blood ethanol levels in sober alcohol users seen in an emergency room. Life Sci 28:1053–1056
188. Sullivan JB, Hauptman M, Bronstein AC (1987) Lack of observable intoxication in humans with high plasma alcohol concentrations. J Forensic Sci 32:1660–1665
189. Garriott JC (1996) Pharmacology and toxicology of ethyl alcohol. In: Medicolegal aspects of alcohol, 3rd edn. Lawyers & Judges, Tucson
190. Money K, Myles W (1974) Heavy water nystagmus and effects of alcohol. Nature 247:404–405
191. Behrens MM (1978) Nystagmus. J Ophthalmol Clin 18:57–82
192. Aschan G (1958) Different types of alcohol nystagmus. Acta Otolaryngol Suppl 140:69–78
193. Aschan G, Bergstedt M, Goldberg L, Laurell L (1956) Positional nystagmus in man during and after alcohol intoxication. Q J Stud Alcohol 17:381–405
194. Goding GS, Dobie RA (1986) Gaze nystagmus and blood alcohol. Laryngoscope 96:713–717
195. Belton H (1987) Lateral nystagmus: a specific diagnostic sign of ethyl alcohol intoxication. N Z Med J 100:534–535
196. Eakins WA (1977) Clinical signs and the level of blood alcohol. Police Surg 11:8–15
197. Willoughby EW (1987) Nystagmus and alcohol intoxication. N Z Med J 100:640
198. Booker JL (2004) The Horizontal Gaze Nystagmus test: fraudulent science in the American courts. Sci Justice 44(3):133–139
199. Moczula B (1996) Alcohol and the law: the legal framework of scientific evidence and expert testimony. In: Garriott JC (ed) Medicolegal aspects of alcohol, 3rd edn. Lawyers & Judges, Tucson
200. British Medical Association (1954) The Recognition of Intoxication. Report of a Special Committee of the British Medical Association. BMA, London
201. Tennant F (1988) The rapid eye test to detect drug abuse. Postgrad Med 84:108–114
202. Fleming P, Stewart D (1998) Drugs and driving: training implications for police officers and police surgeons. Home Office Police Policy Directorate, London
203. Simpson-Crawford T, Slater SW (1971) Eye signs in suspected drinking drivers: clinical examination and relation to blood alcohol. N Z Med J 74:92–96
204. Johnson K, Pisoni DB, Bernacki RH (1990) Do voice recordings reveal whether a person is intoxicated? A case study. Phonetica 47:215–237
205. Martin CS (1998) Measuring acute alcohol impairment. In: Karch SB (ed) Drug abuse handbook. CRC Press, Boca Raton, pp 309–326
206. Potter JF, Watson RDS, Skan W, Beevers DG (1986) The pressor and metabolic effects of alcohol in normotensive subjects. Hypertension 8:625–631
207. Kelbaek H, Gjorup T, Brynjolf I, Christensen NJ, Godtfredsen J (1985) Acute effects of alcohol on left ventricular function in healthy subjects at rest and during upright exercise. Am J Cardiol 55:164–167
208. Kaye S, Haag HB (1957) Terminal blood alcohol concentrations in 94 fatal cases of alcoholism. JAMA 165:451–452
209. Johnson RA, Noll EC, Rodney WM (1982) Survival after a serum ethanol level of 1.5 per cent. Lancet 2:1394
210. Rix KJB (1989) 'Alcohol intoxication' or 'drunkenness': is there a difference? Med Sci Law 29:100–106

211. American Psychiatric Association (2000) Diagnostic and statistical manual of mental disorders, 4th edn (text revision). APA, Washington
212. Norfolk GA (1998) Deaths in police custody during 1994: a retrospective analysis. J Clin Forensic Med 5:49–54
213. Payne-James JJ, Keys DW, Jerreat PG (2005) Salivary alcohol measurement: use in clinical forensic medical practice. J Clin Forensic Med 2:41–44
214. Royal College of Psychiatrists (1986) Alcohol: our favourite drug. Royal College of Psychiatrists, London
215. BMA Board of Science (2008) Alcohol misuse. Tackling the UK epidemic. BMA, London
216. The National Institute for Health and Clinical Excellence (NICE) (2010) Alcohol-use disorders. Diagnosis and clinical management of alcohol-related physical complications. CG100 Quick reference guide. www.nice.org.uk
217. Deehan A, Stark MM, Marshall EJ, Hanrahan B, Strang J (1998) Drunken detainees in police custody: is brief intervention by the forensic medical examiner feasible? Crim Behav Ment Health 8:214–221
218. Reilly D, Van Beurden E, Mitchell E, Dight R, Scott C, Beard J (1998) Alcohol education in licensed premises using brief intervention strategies. Addiction 93:385–398
219. Midanik L (1982) The validity of self-reported alcohol consumption and alcohol problems: a literature review. Br J Addict 77:357–382
220. Babor TF, Ramon de la Fuente J, Saunders J, Grant M (1992) AUDIT, The alcohol use disorders identification test: guidelines for use in primary health care. World Health Organization, Geneva
221. Raistrick D, Heather N, Godfrey C (2006) Review of the effectiveness of treatment for alcohol problems. National Treatment Agency for Substance Misuse, London
222. Pokorny AD, Miller BA, Kaplan HB (1972) The brief MAST: a shortened version of the Michigan alcoholism screening test. Am J Psychiatry 129:342–345
223. Hedlund JL, Vieweg BW (1984) The Michigan alcoholism screening test (MAST): a comprehensive review. J Oper Psychiatry 15:55–65
224. Mayfield D, McLeod G, Hall P (1974) The CAGE questionnaire: validation of a new alcoholism screening instrument. Am J Psychiatry 131:1121–1123
225. Ewing JA (1984) Detecting alcoholism. The CAGE questionnaire. JAMA 252:1905–1907
226. Romach MK, Sellers EM (1991) Management of the alcohol withdrawal syndrome. Annu Rev Med 42:323–340
227. Naik P, Lawton J (1993) Pharmacological management of alcohol withdrawal. Br J Hosp Med 50:265–269
228. Mayo-Smith MF; for the American Society of Addiction Medicine Working Group on Pharmacological Management of Alcohol Withdrawal (1997) Pharmacological management of alcohol withdrawal. A meta-analysis and evidence-based practice guideline. JAMA 278:144–151
229. Naik P, Lawton J (1996) Assessment and management of individuals under the influence of alcohol in police custody. J Clin Forensic Med 3:37–44
230. Linnoila MI (1990) Benzodiazepines and alcohol. J Psychiatr Res 24(suppl 2):121–127
231. Edwards G, Marshall EJ, Cook CCH (2003) The treatment of drinking problems. A guide of the helping professions, 4th edn. Cambridge University press, Cambridge
232. Ling W, Wesson DR (1990) Drugs of abuse: opiates, in addiction medicine (special issue). West J Med 152:565–572
233. Roth BA, Benowitz NL, Olson KR (1998) Emergency management of drug-abuse-related disorders. In: Karch SB (ed) Drug abuse handbook. CRC Press, Boca Raton
234. Benowitz NL (2007) Medical complications of drug abuse, Solvents. In: Karch SB (ed) Drug abuse handbook, 2nd edn. CRC Press, Boca Raton

Chapter 13
Deaths in Custody

Richard T. Shepherd

Introduction

The Forensic Physician will, in all probability, have to deal with a death in police custody at some point in his or her career. This chapter aims to provide a broad basis for the understanding of the disease processes and the mechanisms that may lead to death and also to provide some understanding of the current thinking behind deaths associated with restraint.

Definition

In considering any death associated with detention by officials of any state, caused by whatever means, each state will define, according to their own legal system, the situations that are categorised as being "in custody" [1]. The worldwide variation in these definitions has caused, and continues to cause, considerable confusion in any discussion of this subject. For the purposes of this chapter "in custody" relates to any individual who is either under arrest or otherwise under police control and, while similar deaths may occur in prison, on psychiatric wards or in other situations where people are detained against their will, it is the deaths specifically associated with police detention that will form the basis for the discussion here.

Having defined the broad parameters of the subject, it is important to distinguish between the different types of custodial deaths since it is deaths that are related to direct police actions (acts of commission) that seem to cause the greatest concern to

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the family, the public and the press. It is also important to remember that police involvement in the detention of individuals extends beyond direct physical contact and includes a “duty of care” to that individual and “lack of care” may be termed “acts of omission”. Lack of police action, or “care”, has also been responsible for deaths in custody. These acts are considerably harder to define and perhaps sometimes result from the police being placed in, or assuming, a role of caring (for instance, in states of alcoholic intoxication or acute psychiatric conditions) that are beyond their competence or which they are not equipped or trained to fulfil.

Police involvement with an individual can also include those who are being pursued by the police either on foot or by vehicle, those who have been stopped and are being questioned outside the environment of a police station and those who have become unwell through natural causes while either in contact with or in custody of the police.

The definitions of “death in custody” are therefore wide, and attempts at simple definitions are fraught with difficulty. Any definition will have to cover a multitude of variable factors, in various circumstances and with a wide variety of individuals [2]. The crucial point is that, in a civilised society, the police owe a duty of care to each and every member of the public with whom they have contact and it is essential that every police officer, whether acting or reacting to events, understands and is aware of the welfare of the individual or individuals with whom he or she is dealing.

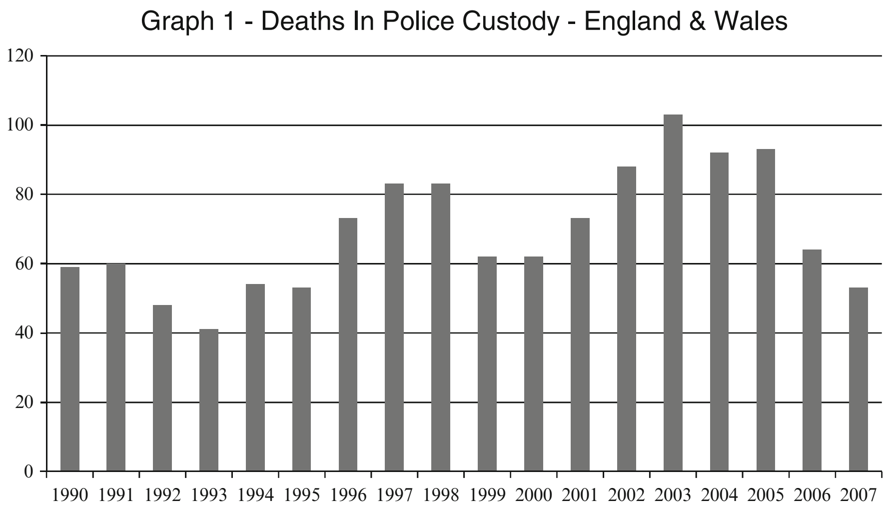
Statistics

Because of the lack of a standard international definition of “death in custody”, the simple comparison of the published raw data from different countries is of no value. The number of deaths recorded in Police Custody in England and Wales from 1990 to 2007 [3] shows considerable variation year to year, initial thoughts of an encouraging decline at the millennium mentioned in earlier editions of this book has not been continued and the peak in 1997 & 1998 was followed by an even higher peak in 2003 (Graph 13.1). The figures for Australia for the same period (1990–2007) shows smaller changes [4] (Graph 13.2) but again there are peaks and troughs. This raw data must be treated with considerable care since any changes in the death rates may not be the result of changes in the policy and practice of care for prisoners but other, undetermined, factors such as increases or reductions in arrest rates over the period as a result of changes in local policing procedures or central governmental policy.

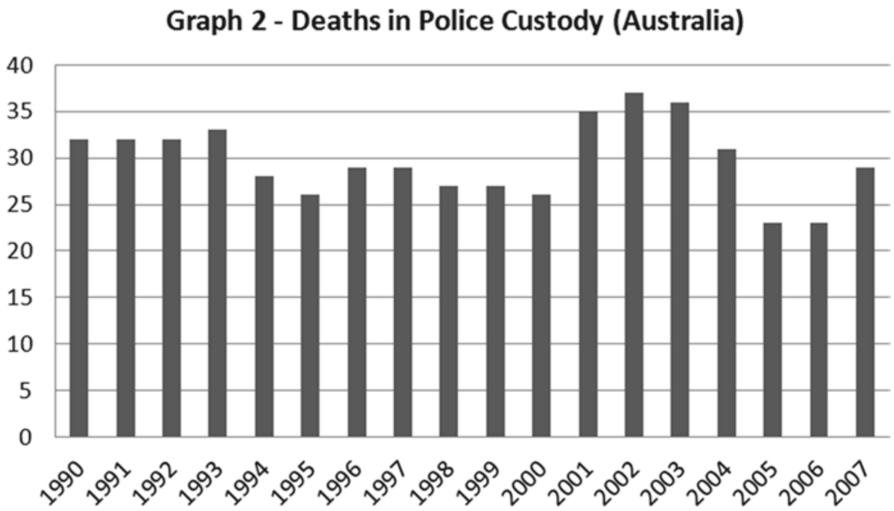
Investigation of Deaths in Custody

Legal Framework

In the United Kingdom, all deaths occurring in prison (or youth custody) [5] must be referred to the Coroner who holds the jurisdiction for that area. However, no such obligation exists concerning deaths in police custody although the Home



Graph 13.1 Deaths in custody in England & Wales



Graph 13.2 Deaths in custody in Australia

Office recommends [6] that all deaths falling into even the widest definition of "in custody" should be subject to Coronial Inquest and hence a full inquiry into the facts and a full postmortem examination should be performed. This acceptance that all deaths occurring in custody should be fully investigated and considered by the legal system must represent the ideal situation; however, not every country will follow this, and some local variations can and do occur particularly in the USA.

Protocol

No standard or agreed protocol has been devised for the postmortem examination of these deaths and, as a result, variation in the reported details of these examinations is to be expected. These differences in the procedures and the number and type of the specialist tests performed results in considerable variation in the pathological detail available as a basis for establishing the cause of death and hence available for presentation at any subsequent inquest. The absence of a defined protocol hinders considerably the analysis of the results of these examinations and makes even the most simple comparisons unreliable. There is always a need for a properly established academic study of all of these deaths such as that performed in Australia under the auspices of the Australian Institute of Criminology [7], and in 2009 the UK government, as a joint venture by Department of Health, Department of Justice and the Home Office, constituted the Independent Advisory Panel on Deaths in Custody to inform and advise the joint Ministerial Board on Deaths in Custody [8].

In the UK, the Police Complaints Authority (PCA) was replaced by the Independent Police Complaints Commission (IPCC) in April 2004 under the Police Reform Act after considerable reservations were expressed by many groups over a prolonged period of time about the independence of the PCA which was composed mainly of serving or retired police officers [9]. The IPCC has a major role in the management of the investigations of all deaths in custody and it also investigates many of the more serious complaints, including allegations of misconduct against the police in England and Wales.

Terminology

In addition to the lack of reproducibility of the postmortem examinations, the terminology used by the pathologists to define the cause of death, particularly in the form required for the registration of the death, may often be idiosyncratic, and similar disease processes may be denoted by different pathologists using many different phrases. For example, damage to the heart muscle caused by narrowing of the coronary arteries by atheroma may be termed simply Ischaemic Heart Disease or it may be called Myocardial Ischaemia due to Coronary Atheroma or even by the "lay" terminology Heart Attack [10]. This marked variation in terminology may lead to confusion particularly among lay people attempting to understand the cause and the manner of death. A considerable amount of research [1, 10] has been produced based upon such lay assessments of the pathological features of a death and this has, at times, resulted in increased confusion rather than clarification of the issues involved.

If the issues regarding the definition of "in custody", the variation in the postmortem examinations, the production of postmortem reports, and the analysis of subsequent specialist tests, all raise problems within a single country, then the consideration of these deaths internationally produces almost insuperable conflicts of medical terminology and judicial systems.

Deaths Related to the Phases of the Police Custodial Process

In an attempt to add some clarity to the situation, it is possible to state that whatever national definition of "in custody" is used, a number of phases of the custody process can be identified and the types of deaths which occur during these phases can be analysed. Clearly a death, either sudden or delayed, may occur for many reasons even in the absence of police but since it is the involvement of police that is the *sine qua non* of "in custody" deaths, the first phase must be considered to be the presence of police officers at the scene. Subsequently, an arrest may be made with or without the use of restraint techniques and the prisoner will then be transported to a police station. This transport will most commonly involve a period within a police vehicle which may be a car, a van with seating or some other vehicle. Many factors may determine the type of transport used and the position of the individual in that vehicle. Detention in the police station will be followed by a period or periods of interview interspersed with periods of time incarcerated, usually alone, within a cell. Following interview the individual may be released directly, charged and then released or they may be detained to appear before a court. It is at this point that custody moves from the Police to other authorities, usually to the prison service.

When considering the types of death that can occur during each of these phases, six main groups can be identified based on the reported causes of death. The groups are:

- Natural deaths
- Deaths associated with accidental trauma
- Deaths related directly to the use of alcohol
- Deaths related to the use of other drugs
- Deaths associated with self-inflicted injury
- Deaths associated with injuries deliberately inflicted by a third party

It is clear that different factors may lead directly to, or play a major part in, the death of an individual while in custody and that different factors will play their part at different phases in the period of custody (see Table 13.1).

Acute alcohol intoxication or the deleterious effects of drugs are, in most cases, likely to have a decreasing effect as they are metabolised or excreted from the individual's body. They are therefore most likely to cause death in the post arrest and early detention phases and it is important to note that their effects will be least visible to those with the "duty of care" while the individual is out of sight, detained

Table 13.1 Expected types of deaths in different phases of custody

	Natural	Accidental trauma	Alchohol	Drug	Self inflicted	Deliberately inflicted
Pre arrest	++	+++	++	++	±	±
Arrest	++	+++	++	++	±	+++
Detention	+	+	+++	+++	++	++
Interview	+	+	++	++	+++	++
Charge	+	+	−	−	+++	±

within a cell – particularly if they are alone within that cell. Similarly the effects of trauma, whether accidentally or deliberately inflicted, are most likely to become apparent in the early phases of detention and it would only be on rare occasions that the effects of such trauma would result in fatalities at a later stage although this has occurred on several occasions in particular with head injuries [10]. Conversely death resulting from self-inflicted injuries are unlikely to occur in the pre-arrest and the arrest phases of detention but can and do occur when the individual is placed in a cell and is not under immediate and constant supervision.

Deaths from natural causes on the other hand can occur at almost any time during the period of arrest and detention. It is possible that the stress (whether emotional or physical or both) associated with the initial phases of arrest and with the subsequent, more emotionally stressful, phases during detention are likely to precipitate the death of the susceptible individuals through the effects of sympathetic stimulation and the release of adrenalin. Deaths from natural causes should be reduced by the medical examination and supervision of detainees from the time of initial detention and throughout the period of detention (see Chap. 9).

It is, however, quite clear that the deaths described in many reports are not "pure" i.e. they are not attributable to any one single category. Individuals with heart disease may also be under the influence of alcohol, individuals under the influence of alcohol or drugs may also have suffered trauma, either accidental or deliberate, prior to or during their detention. In determining the cause of death it can therefore be extremely difficult to give weight to each of the factors that could be identified during the period of detention. There is clearly great need for early assessment and accurate diagnosis of natural disease (physical or psychiatric), of alcohol or drug intoxication and for the identification, documentation and treatment of all types of trauma.

The removal of an individual's freedom places upon the police a duty of care to that individual and it is only by the active assessment of each and every person entering police custody and the continuing care of that individual that the number of deaths in custody can be reduced.

Causes of Death

Natural Causes

Apart from a few unusual cases, deaths due to natural causes while in police custody fall into the groups of disease processes that are commonly associated with sudden natural death in the community.

Cardiovascular Disease

The most common cause of death in the community and of sudden death in particular, is cardiac disease, and within this group those deaths recorded as being due to ischaemic heart disease or coronary atheroma are the most common. The exact definitions and criteria for the pathological diagnosis of significant ischaemic heart disease [11] are not within the scope of this chapter. While there is a clear increase in the incidence of this cause of death with age [12], it is important to remember that a small percentage of people in the younger age groups, most commonly those with hyper-cholesterolaemia and hyperlipidaemia, may also have significant coronary artery disease and since it is the younger age groups that are more likely to be arrested by the police these few individuals may assume great significance.

The significance of coronary atheroma is that individuals with this disease are particularly prone to the development of dysrhythmias during periods of stress when the adrenaline-induced tachycardia results in a decreased ability to perfuse areas of the myocardium during diastole which may result in the development of ischaemic ectopic electrical foci. Deaths may be preceded by the development of classical cardiac chest pain or it may present with sudden collapse and death without prior warning.

Individuals suffering from significant myocardial hypertrophy due to chronic hypertension are also at greater risk during periods of stress. Once again it is the older age groups that are most commonly affected by essential hypertension which may also render these individuals susceptible to focal lack of myocardial perfusion during periods of tachycardia. In addition to these two disease processes, there are also the much rarer diseases or syndromes that may cause sudden death which are possibly more significant in the context of "deaths in custody" since some of them tend to affect younger age groups in particular. Congenital valvular disease (e.g. floppy mitral valve disease) and congenital myocardial disease (e.g. the cardiomyopathies) may both render an individual more susceptible to sudden cardiac death and, as with ischaemic or hypertensive heart disease, sudden death is more likely when the sympathetic stimulation which is associated with stress, (emotional and/or physical) has resulted in tachycardia.

Current research is now focusing on a genetic basis for many other sudden cardiac deaths in the younger age groups. These genetically mediated disease processes (for example, the prolonged QT syndrome and channelopathies) can sometimes be diagnosed in life by ECG, however, after death their presence, and hence their possible relationship to the sudden death, can be inferred only from the detection of specific gene defects [13]. The examination for these specific gene markers in any sudden death in police custody must now be considered essential especially in the absence of other causes of death.

Myocarditis and rheumatic heart disease are rare causes of death in young individuals although such deaths may occur without any prior indication of a disease process in individuals in police custody and elsewhere.

Other cardiovascular causes of sudden death are also, for the most part, age related. The rupture of atheromatous aortic aneurysms is a disease almost entirely confined to late middle and old age while the rarer forms of aortitis and collagen diseases of the aorta [14], which may also result in rupture, are more commonly seen in the younger age groups. The diseases that are not age related may be associated with a long history of alcohol or drug abuse and the long term effects may result in alcoholic cardiomyopathy, cocaine-related myocardial scarring or other coronary artery or myocardial effects that can result in a sudden death even after long-term abstinence from, or just short-term lack of, alcohol or the preferred drug(s) of abuse.

Pulmonary emboli can cause sudden death or they may present as dyspnoea and chest pain. It is most unusual for deep venous thrombosis of the leg veins to be present in a young active male; however, the association between some types of the combined oral contraceptive pill and the development of thromboses has been known for some time [15] and may render a small subgroup of the female population at greater risk of pulmonary emboli than the general population.

Central Nervous System

The stress associated with arrest and detention in custody may also have significant effects upon the cerebro-vascular system and may, in susceptible individuals, precipitate intracerebral haemorrhage by the rupture of congenital or acquired aneurysms or vascular malformations. Ruptured berry aneurysms will result in the development of acute subarachnoid haemorrhages. It is less likely that these intracranial haemorrhages will result in sudden death but they may result in sudden unconsciousness which leads ultimately to death. Clearly the distinction between haemorrhage due to a natural disease process and that due to trauma will need to be established, and a specialist neuropathological examination will be required should death occur.

As with the heart, the possibility that an infectious process within the central nervous system is the cause of sudden collapse and death must be considered. It is however unlikely that meningitis or encephalitis will present without any prodromal symptoms. Epilepsy is unlikely to develop *de novo* following arrest and detention but epilepsy can and does lead to sudden collapse and death and a pre-existing history of epilepsy is clearly important. Any individual known to suffer from epilepsy should be monitored with the utmost care and their prescribed medication continued.

Other forms of intracranial pathology that may lead to sudden death include tumours, both benign and malignant, and such rarities as the development of colloid cysts of the ventricular system.

Endocrine

Diabetes mellitus should raise similar concerns to those associated with epilepsy since poorly controlled diabetes may on occasions be the direct cause of sudden death. And diabetes generally, through its association with an increased incidence of arterial disease, is a major factor in the development of coronary artery disease in the younger age groups. At postmortem consideration must be given, in all cases of sudden death in a young individual but particularly when there is a history of diabetes mellitus, to the sampling of the vitreous humour in an attempt to determine the blood glucose level at the time of death. The samples need to be taken as soon after death as possible to avoid post mortem utilisation of the intraocular glucose yielding erroneous results [16].

Other Causes

There are many other natural disease processes that could theoretically lead to sudden collapse and death. Amongst these is asthma, a disease that is usually unlikely to lead to sudden death if adequately treated and supervised but which may, if untreated and unsupervised and in stressful circumstances, result in the individual being found dead in their cell. Other disease processes include the development of haemoptysis, from tuberculosis or pulmonary malignancy, or haematemesis, from peptic ulceration or oesophageal varices, which can be life threatening and which may, because of the bleeding, be considered to be the result of trauma rather than a natural disease process. These cases should present no problem to an experienced pathologist following a full postmortem examination.

Conclusion

The significant feature when considering possible natural causes of death of an individual in police custody is that some diseases can lead to rapid collapse and death with no prior warning in a young individual who is apparently fit and well immediately prior to the collapse. There is no method that the police can use to determine which of the individuals they encounter will be suffering from these diseases or from a genetic abnormality that may lead to electrical disturbances within the myocardium. Indeed many of these disease processes can only be diagnosed after complex medical testing following the taking of a full medical history.

The fact that many of these diseases are rare in the age group that is most likely to be detained in custody places additional burdens upon the police officers required to care for these individuals and also upon the doctors required to examine and treat them in the police station. The difficulties that these cases present to the pathologist lies in the need to have an awareness of all of the possible natural causes of sudden death and the need for a careful determination, and if necessary exclusion, of all of these causes – cardiac, neurological, endocrine etc., before forming the conclusion that some other factor has resulted in death.

Accidental Trauma

It is clear that determining if trauma is the result of an accident or not may depend entirely on the “eye of the beholder”. As an example of this it is impossible at postmortem to determine if the injuries caused following a fall from a window during arrest were the result of an accidental fall, an intended jump or a deliberate push from that window since any points of contact with the building during the descent and the contact with the ground will result in the same injuries whatever the initial “cause”. Pathologically the only features of relevance in determining the exact cause of the initiation of the descent are the identification of specific gripping, holding or other restraining injuries that could have occurred prior to the descent or the identification of marks or injuries that may or may not be present (for instance to the fingers) that could be ascribed to attempts to hold on to a window ledge etc. All of the injuries or marks found on the body will have to be correlated with witness statements both from the police and from any other parties present at the time of the fall. Often the true interpretation of many of the injuries and marks found during the post mortem will only become clear when these statements are considered.

In general terms, however, accidental trauma can be caused by many events during the course of an arrest. Falls onto the ground may occur from a height or from standing. Gripping and restraining injuries are commonly present on many areas of the body but are likely to be most common on the arms. The site and significance of the injuries present will depend on the descriptions of the events before, during and after the arrest.

It is essential that all injuries, no matter how apparently trivial, present on a detained individual are carefully documented by the forensic physician who examines the detainee whether at a police station or elsewhere. Contemporaneous photographs are always extremely helpful in these circumstances and all injuries should be photographed with and without a scale. The ageing of bruises is often critical and documentation of any colour changes in bruises can be of importance. If these changes are to be reliably recorded photographically a standard colour strip must also be included in the photograph(s).

In terms of a cause of death few of the minor injuries will be relevant but they may provide an indication of the extent and degree of the force that was applied to effect an arrest and, as such, they can be of immense value. Injuries present in sites that are known to be of high risk, for instance around the neck, must be examined, documented and interpreted with particular care. All of the injuries need to be interpreted in the light of witness statements and can provide very useful corroborative evidence.

Alcohol and Drug Related Deaths

Alcohol

Alcohol is one of the most commonly used drugs in the world. The small ethyl alcohol molecule can pass easily through the blood–brain barrier to the CNS where it has direct suppressant affects on the whole of the central nervous system. At low concentrations the specialised cells of the cerebral cortex are affected but as the concentration increases the depressive effects involve the higher areas of the brain resulting in increasingly disinhibited behaviour. Still higher levels of alcohol result in the depressant effects involving the lower levels of brain function, including the vital cardiorespiratory centres in the midbrain and the medulla, predisposing the intoxicated individual to cardiorespiratory depression or arrest. Alcohol levels in excess of 300 mg/dL are considered to be potentially lethal although some individuals have survived, usually with medical attention, with far higher levels. And some, it must be remembered, have died with far lower levels of alcohol in their blood stream.

The effects of alcohol are however not confined to the brain, there is also marked peripheral vasodilation resulting in increased heat loss which may, on occasions, lead to hypothermia. The adverse effects of alcohol on the coronary circulation, particularly when associated with coronary atheroma may lead to myocardial ischaemia and the development of dysrhythmias and sudden death.

Alcohol also has marked diuretic effects and when combined with the ingestion of large quantities of fluid (particularly in beer and lager drinking) this may result in electrolyte disturbances particularly hyponatraemia.

The chronic effects of alcohol involve many of the internal organs; alcoholic cardiomyopathy, hepatic steatosis and cirrhosis are the most common and all can lead to sudden death.

Alcohol may also be a major factor in causing death by predisposing the individual to accidental trauma and by obscuring the effects of that trauma [17]. This is particularly the case in head injuries when the changes in conscious level are attributed to the effects of alcohol rather than an identified or unidentified head injury.

Alcohol is also a gastric irritant and may precipitate vomiting when taken in excess. This, combined with the effects of decreased consciousness and the reduced laryngeal reflexes associated with intoxication, result in a significantly increased risk of aspiration of vomit into the airways and death. Such an event is unpredictable and, without constant supervision, unpreventable.

The anaesthetic effects of alcohol may also result in deaths from asphyxiation. These deaths are the result of the intoxicated individual moving into or being placed or left in a position that impedes respiration either by occlusion of the external respiratory orifices, the internal airways (particularly the larynx) or restricts the free movement of the chest wall. These positions may result from lying face down on a bed, marked extension or flexion of the neck or lying across an edge with the head down. Deaths resulting from impairment of respiration in this manner classically result in profound asphyxial changes involving the upper body and these deaths are ascribed to postural asphyxia.

The metabolism of alcohol follows pathways that results in temporary increase of toxic chemicals including ketones (acetaldehyde, β-hydroxybutyrate etc.) in the blood. These metabolic products result in raised blood acidity and cause further disturbances in sodium / potassium, glucose and other metabolic pathways. If the natural balancing chemical buffers of the body are overcome and the blood acidity falls significantly, cardiac dysrhythmias can be produced and sudden death can occur. Postmortem analysis of the blood for β-hydroxybutyrate (BHB) is now readily available and should be performed in all custodial deaths.

Given the speed with which an individual under the influence of alcohol can die from either the aspiration of vomit or from postural asphyxia it is very doubtful if a police station cell is the correct environment for their recovery from intoxication.

Drugs

Drug use is now so ubiquitous in western society that any examination of a potential detainee by a forensic physician must include a very careful evaluation of drug use whether in the past or recently. The skill of the forensic physician will undoubtedly be stretched to the full in the evaluation of the history given and this is discussed fully in Chap. 12; much may depend on the failure to continue prescribed medication as on the failure to identify a drug abuser who then suffers from withdrawal whilst in custody.

In terms of deaths in custody all drug use, whether social, abusive or therapeutic, is relevant [18] and the possibility that a detainee may have abused just one drug or a combination of drugs with or without alcohol prior to death must be positively excluded. A full drug screen on blood and, if available, urine is imperative. Some laboratories will also examine samples of bile and/or liver to detect evidence of previous drug abuse. At post mortem the contents of the whole bowel must be examined to determine if packets or “wraps” of drugs have been ingested in order to prevent detection during arrest or for “body packing”.

The management of acute drug intoxication is a matter of clinical judgment but with adequate medical care it is unlikely that, except in exceptional circumstances, drug intoxication alone will to lead to sudden death in custody.

Deliberate Injuries

Baton Blows

Blows from a baton are usually easily identified in that forceful blows produce the classic “tram line” type injuries on the skin. “Tram line” injuries are typical of a blow from a linear blunt object, the areas of the skin that are most traumatised are not those at the middle of the site of contact where the skin is most evenly compressed but rather at the margins on the contact site where the stretching and distortion of the skin, and hence the damage to the underlying tissues including the blood vessels, is most pronounced. A linear object will, almost by definition, have two such margins which run parallel and a blow from such an object results in two, linear, parallel bruises hence the terminology “Tram line”.

Blows from a baton may also result in deeper bruising, nerve damage and fractured bones. The deeper injuries tend to reflect the use of greater force but it is not possible to correlate with any degree of certainty the amount of force needed to cause a particular injury in any one individual.

It is essential for both the forensic physician who examines a living victim of a blow to the head from a baton (or from any other cause) and the pathologist who performs a post mortem examination to remember that significant cerebral trauma can have been caused even in the absence of obvious external trauma or skull fractures and it would be a matter of prudence to assess with great care anyone who has received, or complains of receiving, a head injury from a baton or from any other cause and to consider carefully if referral to hospital for a full neurological assessment would be advisable.

Neck Holds

Pressure on and around the neck is well known to be a potentially lethal action [16]. Death can be caused following compression of the neck by any one of four mechanisms or by a combination of two or more of them.

- Airway obstruction by direct compression of the larynx or trachea or by the pressure on the neck raising the larynx upwards and causing the superior aspect of the pharynx to be occluded by the base of the tongue. This can be achieved by pressure of a forearm across the front of the neck, sometimes called the "Choke Hold".
- Occlusion of the veins in the neck. The low pressure in the venous system and the thin yielding nature of the vein walls makes venous occlusion more easily achievable than arterial occlusion; however, the large reserve capacity of the venous system makes it unlikely that rapid death would result even if complete occlusion was achieved, unless some other factor supervened.
- Compression or occlusion of the carotid arteries. This is harder to achieve than venous occlusion due to the higher pressure in the arterial system and the thickness of the arterial walls; however, the effects of occlusion will become apparent much quicker. Knight [16] records that occlusion of the carotid circulation for a period of 4 min or more may result in brain damage and Reay et al. [19] demonstrated significant changes in blood flow in the face of five individuals who were subjected to compression of the carotid arteries by the application of a "sleeper hold" in experimental conditions. A sleeper hold is applied when the upper arm compresses one side of the neck and the forearm the other and the larynx rests in the "V" formed by the elbow.
- The fourth mechanism by which death can occur during pressure to the neck results from stimulation of the vagus nerve by direct pressure in its course down the neck or as a result of stimulation of the carotid sinus. Vagal stimulation results in bradycardia which may progress to asystole or, in some cases, immediate asystole.

Mercy et al. [20] reviewed 20 deaths where neck holds had been applied and concluded that in 19 of these cases the application of the neck hold was associated with the death. Conversely, Kowai [21] concluded that the use of the Choke Hold could take between 10 and 20 s to cause unconsciousness and therefore it was safe. Clearly they did not experience the vagal effects of this hold in their experiments.

Neck holds are commonly used in many forms of wrestling or martial arts and in these situations they are seldom associated with fatalities possibly because of the ability of the person held to indicate their willingness to submit to a referee and so cause the hold to be released. No such authority is present during a restraint by police and perhaps this is why fatalities are recorded in this situation. In the United Kingdom, the use of neck holds by police during restraint is specifically prohibited and officers are warned during their training of the potentially fatal effects of applying any pressure to the neck. In the USA, however, neck holds are an approved method of restraint.

The pathological examination of deaths associated with compression of the neck requires a detailed and careful dissection of the neck structures [22]. The finding of injuries to the muscular, cartilagenous, vascular, or neural components of the neck must, however, be interpreted in the light of the events of the restraint, the actions of the restrainers and the subsequent resuscitation (if any). Pressure on the neck to maintain an airway following cardiac or respiratory arrest may result in bruising which could be confused with pressure prior to, or indeed causing, that arrest. Therapeutic insertion of cannulae during active resuscitation by paramedics or in the hospital very commonly leads to quite marked haemorrhage into the neck which, while it is unlikely to be confused with bruising caused by a neck hold, may mask any bruising that was present.

Pressure on the neck is not, of course, the only mechanism whereby an individual may suffer anoxia or asphyxiation. Any action that occludes, partially or completely, the mouth and/or the nose will result in difficulty in breathing and may result in asphyxiation. The features of these other causes of asphyxiation, traumatic or restraint asphyxia, will be discussed later.

Homicide

There have been a number of cases where individuals have been murdered in the cell by another inmate, these deaths are most commonly associated with blunt trauma but strangulation, stabbing and other methods may be employed if suitable weapons are available. It is also evident that individuals have been deliberately assaulted and killed by police officers during arrest and detention.

The forensic physician should always be aware of the possibility that excessive force may have been applied by the police or that deliberately homicidal injuries may have been inflicted. If injuries are present on any individual in their care these injuries must be carefully documented and, if they are beyond that which the physician considers reasonable in the circumstances, their concerns should be expressed immediately to a senior officer, a legal representative of the detainee and through an official complaints procedure. The physician also has the duty to ensure that no further harm comes to that person.

Self-Inflicted Injuries

Suicidal deaths in custody are a cause for continuing public concern. The methods used are variable but reflect the materials available to the individual at that time.

Hanging

In order to effect a hanging suicide the individual must have two things; an object that can be made into a noose and a point to fix it to. In addition they must be able to place their body so that their own body weight can be used to apply pressure to their neck via the noose.

The materials and objects that can be made into a noose are legion and vary from the obvious (ties, belts, shoelaces, etc) to the unusual (underwear, shirts, etc). In order to attempt to reduce the possibility of hanging suicides, many cells in police stations have been redesigned and attachment points for the noose (pipes, bars, etc) have been removed or covered. The lack of these obvious points did not, however, deter some individuals who placed the bed “on end” and used the upper end as the fixing point. Installation of fixed beds or benching should preclude the use of that method in future. It must be remembered that hanging can still be achieved, although is clearly more difficult, from a low suspension point and any protrusion from a wall or fitment in a cell can potentially be used as the upper attachment for the noose.

In addition to removal of the fixing points, attempts have been made to remove the items that have been used as nooses in the past and belts, shoelaces, etc are sometimes taken from prisoners. Paper clothing has been used although this has not been entirely successful as it entails removing all of the individual’s clothing which is clearly impractical in many cases and may raise problems with human rights, and any paper clothing strong enough to withstand any degree of wear would also be strong enough to act as a noose.

The key to preventing hanging suicides lies in the careful evaluation of all individuals who are to be detained and in the design of the cells in which they are held to preclude any possible point for the attachment of a noose.

Given the speed with which hanging can be effected [23], it is most unlikely that anything other than a permanent watch over the suicidal detainee would provide a foolproof method to prevent hanging in a cell. A cycle of 15 min checks will allow more than ample time for an individual to hang themselves and cannot be considered to be adequate protection against this type of suicide.

Ligature Strangulation

As the possibility of suspension is reduced by the changes in the design of the cells, the possibility of other forms of self asphyxiation are likely to increase. Self strangulation by ligature is considered to be possible but difficult [16]; since the pressure has to be applied to the neck in these cases by the conscious muscular effort of the hands and arms, it follows that when consciousness is lost and the muscular tone lessens the pressure on the ligature will decrease, the airway obstruction and/or the vascular occlusion will cease and death will generally be averted. If, however, the ligature is knotted or if the material is "non-slip" and looped around itself then it is possible for the individual to apply the pressure to the neck and for that pressure to be maintained even after consciousness is lost and, as a result, death may follow.

As with hanging, the key to preventing these deaths lies in careful evaluation and, if necessary, the removal of items of clothing and observation.

Incised Injuries

All prisoners should be carefully searched before incarceration and any sharp objects, or objects that could be sharpened, must be removed. The extent of the search will probably depend on the mental state of the individual and the possibility of an intimate search to exclude weapons concealed in the vagina or rectum should be considered in those individuals considered most at risk. Death from deep incised wounds to the neck or arms can occur very quickly, even if found before death has occurred the effects of profound blood loss may make death inevitable despite attempts at resuscitation.

Drugs

When considering the possibility of suicide using drugs while in police custody the two key factors are, once again, evaluation and searching. Careful searching (possibly including intimate searches in some cases) will prevent the ingestion of drugs by an individual after they have been placed in the cell. The forensic physician must always be aware of the possibility that excessive quantities of a drug or drugs were taken prior to arrest and detention which may exert their effect when the individual is in the cell.

Excited Delirium

Definition

The exact definition of this syndrome remains elusive despite many publications apparently describing similar events [24, 25]. Indeed the many different names given to these apparently similar conditions (Bell's Mania; Agitated Delirium; Excited

Delirium; Acute Exhaustive Mania) over the years indicate that it is a syndrome which may have many different facets not all of which may be present in any single case. All of these descriptions, however, do comment on the high potential for sudden collapse and death while the individual is in the highly excited states that they all describe. It is now accepted that such a syndrome does exist and while it is now commonly associated with use and abuse of cocaine [26], it is important to note that it was described in 1849 well before cocaine use and abuse became common [24].

Features

The clinical features of Excited Delirium are generally accepted to be:

- A state of high mental and physiological arousal
- Agitation
- Hyperpyrexia associated with sweating
- Violence, aggression and hostility
- Insensitivity to physical pain or to restraint sprays

In addition to these clinical observable features there will certainly also be significant physiological and biochemical sequelae including dehydration, lactic acidosis and increased catecholamine levels [26]. These biochemical and physiological features may be such that they will render the individual at considerable risk from sudden cardiac arrest and the descriptions of cases of individuals suffering from excited delirium [27] indicates that the sudden death is not uncommon. Shulack [27] also records that "The end may come so suddenly that the attending psychiatrist is left with a chagrined surprise…" and he continues "…the puzzlement is intensified after the autopsy generally fails to disclose any findings which could explain the death". More than 50 years after the publication of that paper it still holds true – but the site of the death may have moved from the ward of a psychiatric hospital to a police station.

The findings noted in by Shulack [27] in 1944 are also repeated today in many cases that have the features of excited delirium, the difference now being that toxicological examination not uncommonly reveals the presence of cocaine or, in a therapeutic environment, neuroleptic drugs and, as a result, it is tempting to relate the cause of death to the presence of the drug or drugs. In the context of restraint associated with death in cases of excited delirium, the presence of injuries to the neck may lead to the conclusion that death resulted from asphyxia but this interpretation needs careful evaluation.

What is perhaps of greater importance is that in all of the cases described in the clinical literature [24, 25, 27–30] there has been a prolonged period of increasingly bizarre and aggressive behaviour often lasting days or weeks before admission to hospital and subsequent death. The clinical evidence available for the deaths associated with police restraint indicates that while there may have been a period of disturbed behaviour before restraint and death, the duration of the period will have been measured in hours and not days. This change in time scale may be due to the different etiology of the cases of excited delirium now seen, and it is possible that the "natural" and the "cocaine induced" types of excited delirium will have different time spans but a common final pathway. This feature will need to be elucidated in the future.

The conclusion that can be reached concerning individuals displaying the symptoms of excited delirium is that they clearly constitute a medical emergency. The police need to be aware of the symptoms of excited delirium and to understand that attempts at restraint are potentially dangerous and that forceful restraint should only be undertaken in circumstances where the individual is a serious risk to himself/herself or to other members of the public.

Ideally persons displaying these symptoms should be contained and a forensic physician should be called to examine them and to offer advice to the police at the scene. The possibility that they should be treated in situ by an emergency psychiatric team with resuscitation equipment and staff available will need to be discussed with the police and, if such an emergency psychiatric team exists, this is probably the best and safest option. If such a team does not exist then the individual will need to be restrained with as much care as possible and taken to the hospital emergency room for a full medical and psychiatric evaluation. These individuals should not be taken directly to a psychiatric unit where resuscitation skills and equipment may not be adequate.

Rapid Unexplained Deaths During Restraint

Reliable and up-to-date statistics on restraint related death in police custody are difficult to obtain, partly because deaths occurring while an individual is actually being restrained are rare and partly because of the inordinate length of time taken by the legal system, both Coronial and Criminal, in investigating and considering these deaths. In the UK Police Research Group Paper [31] which covers the period 1990–1996, 16 cases are identified where police action "may have been associated with the death" amounting to 6% of the deaths that this group studied. Some later statistics [3] indicate that there were fewer "restraint related" deaths in the 10 years 1999–2008; however, the exact definition of "restraint related" has not been established and this renders any statistical analysis, at least, unreliable.

From consideration of the medical aspects of these deaths recorded in the Police Group Research Paper it would appear that six of the deaths were due to natural disease and four were related to drug use or abuse. Of the remaining six cases, one was associated with a baton blow to the head, two to asphyxiation due to pressure to the neck, two to "restraint asphyxia" and one to a head injury. Therefore in the deaths during the 7 years that this group considered, a total of four deaths, less than 1.5% of the 267 deaths in police custody reviewed by this group, were apparently directly associated with asphyxia during restraint.

However, the close association of these deaths with the actions of the police in restraining the individual raises questions about the conclusions reached by the pathologists and accepted by the courts. It is very common for several pathological opinions to be obtained in these cases; in a review of 12 in-custody deaths, an average of three opinions had been obtained (range 1–7) [32]. Indeed in one of the cases cited in this report as being associated with police actions, seven pathological opinions were sought and yet the only one opinion is quoted. This points to the considerable difficulty in determining the relative significance of a number of different, and at times conflicting, areas of medical evidence that are commonly present in these cases.

The area of restraint that appears to be causing the most concern relates to asphyxiation during the act of restraint. It has been known in forensic circles for many years that individuals may asphyxiate if their ability to breathe is reduced by the position in which they are placed or into which they fall [33]. This type of asphyxiation is commonly associated with alcohol or drug intoxication or, rarely, with neurological diseases which prevent the individual extracting themselves from a position that either occludes, partially or completely, their mouth and nose or which limits the freedom of movement of the chest wall. Death resulting from these events has been described as Postural Asphyxia to indicate that it was the posture of the individual that resulted in the airway obstruction rather than the action of a third party.

In 1988, research by Reay et al. [34] was published which was initially thought to show that, in laboratory conditions, the placing of an individual in the hog-tie position significantly increased the time taken to return to resting blood oxygenation levels following moderate exercise. "Hog-tieing" is a form of restraint where the detainee is placed face down and the hands are tied together and then to the feet. Reay concluded that positional restraint (hog-tieing) had "measurable physiological effects". In 1992, Reay published a paper [35] which recorded six cases where, in his opinion, individuals had died as a result of "hog-tieing" and being placed prone in police vehicles. This paper raised the possibility that asphyxiation was occurring to individuals when they could not move themselves to safer positions because of the type of restraint used by the police. The concept of "restraint asphyxia", albeit in a specific set of circumstances, was born.

Since the description of deaths in the prone, hog-tied position, Reay's original concepts have been extended to account for many deaths of individuals simply under restraint but not in the hog-tied position. The term "restraint asphyxia" has been widened to account for these sudden and unexpected deaths during restraint. Considerable pathological and physiological controversy exists regarding the exact effects of the prone position and hog-tieing in the normal effects upon respiration. Further experiments by Chan et al. [36] have cast considerable doubt on Reay's thesis although other experiments by Roeggla et al. [37] appear to support the original theory. While the physiological controversy continues, it is clear to all those involved in the examination and investigation of these deaths that there is a small group of individuals who die suddenly and apparently without warning while being restrained.

Physiological research on simulated restraint revealed [38, 39] that restraint did produce reductions in the ventilatory capacity of the experimental subjects but that this did not impair cardiorespiratory function. In two of the eight healthy subjects, breath holding following even moderate exercise was found to induce hypoxia-related dysrhythmias and it was noted that arterial oxygen saturation fell rapidly even with short breath hold times especially if lung volume was reduced during exhalation.

The problem that currently faces the forensic pathologist is the determination of the cause or causes of these deaths. This is made harder since there are seldom any of the usual asphyxial signs to assist and, even if those signs are present, it is difficult to assign weight or significance to them since similar changes can be caused simply by resuscitation [40, 41].

The major features of asphyxiation are cyanosis, congestion and petechial haemorrhages [14]. These features are seen to a greater or lesser extent in many, but not all, cases of asphyxiation. They often are completely absent in many plastic bag asphyxiations and in hanging, they have variable presence in manual strangulation and they are most commonly seen in ligature strangulation. But their most florid appearance are in deaths associated with postural asphyxia or crush asphyxia cases where death has occurred slowly and where it is associated with some form of pressure or force reducing the ability of the individual to maintain adequate respiratory movement, either from outside the body or from the abdominal contents splinting the diaphragm.

It is of interest then that these features, if present at all in these cases, are, at most, scanty and do not reflect their appearance in other cases of crush asphyxia suggesting that different mechanisms are the cause of death in these two sets of circumstance.

The individuals who die during restraint are not infrequently under the influence of drugs (particularly cocaine) or alcohol, they may be suffering from some underlying natural disease (particularly of the cardiovascular system) or they may have suffered some trauma. These “additional” factors are sometimes seized upon by pathologists and courts to “explain” the death, sometimes even in the face of expert opinion that excludes the additional factor from playing a major part in the death. In the USA, much reliance is placed on the identification of brain biomarkers for cocaine use of even the “diagnosis” of excited delirium at postmortem [42], however, these techniques are not available in the UK and concerns about transatlantic transportation of brains and the lack of a full neuropathological examination have precluded analysis of these biomarkers in UK cases.

It would seem that there is a sub-group of the population who are either permanently or at times and for whatever reason susceptible to the effects of restraint whether those effects be mediated entirely or indeed partially through decreased respiratory effort or some other factor.

There appears then to be a separate entity, the exact cause of which is not yet clear, where otherwise fit and healthy individuals die suddenly while being restrained and yet do not show significant features of asphyxiation. It is to be hoped that further research on the physiology of restraint will elucidate the mechanisms which cause death in these cases. Until these mechanisms are established it would seem reasonable to propose that these deaths should be classified for what they are – rapid

unexplained death during restraint (RUDDR) – rather than to conclude that the cause of death cannot be determined or to ascribe a doubtful medical or toxicological cause of death which does not bear close scrutiny.

Deaths classified as RUDDR must fulfil several criteria:

1. The death must have occurred during restraint and the individual must have collapsed suddenly and without warning.
2. A full external and internal postmortem examination must have been performed by a forensic pathologist which did not reveal macroscopic evidence of significant natural disease and subsequently a full histological examination of the tissues must have been performed which did not reveal microscopic evidence of significant natural disease.
3. Studies must not reveal genetic markers of significant disease.
4. There must be no evidence of significant trauma or of the triad of asphyxial signs.
5. A full toxicological screen must have been performed that did not reveal evidence of drugs or alcohol which, alone or in combination, could have caused death.

The small numbers of these deaths in any single country or indeed worldwide make their analysis very difficult; indeed to search for a single answer that will explain all of these deaths may be futile. The bringing together of these deaths under a single classification would make the identification of cases and their analysis easier.

The problem for the police is that while approaching and restraining an individual they cannot know the background or the medical history nor can they have any idea of the particular (or peculiar) physiological responses of that individual. The techniques that are designed for restraint and the care of the individual after restraint must therefore allow for safe restraint of the most vulnerable sections of the community.

New research into the effects of restraint may possibly lead to a greater understanding of the deleterious effects of restraint and the development of safer restraint techniques. While this experimental work is being performed the only particular advice that can be offered to police officers is that the prone position should be maintained for the minimum amount of time only, no pressure should be applied to the back or the chest of a person restrained on the floor and that that individual should be placed in a kneeling, sitting or standing position to allow for normal respiration as soon as practical.

It should be noted that an individual who is suffering from early, or indeed late, asphyxiation may well struggle more and more in an attempt to breathe and, during a restraint, this increased level of struggling may be perceived by police officers as an renewed attempt to escape resulting in further restriction of movement and subsequent exacerbation of the asphyxial process. Officers need to be taught that once restrained these further episodes of struggling may signify imminent asphyxiation and not continued attempts to escape – that they may represent a struggle to survive and that the police must be aware of this and respond with that in mind.

Since these matters were first brought to forensic and then public attention and improved training and advice to police officers concerning the potential dangers of face down or prone restraints especially if associated with any pressure to the chest or back, there appears to have been a decrease in the number of deaths during restraint in some sectors although the total number of deaths is rising. Even one death in these circumstances is too many and it is hoped that by medical research, improved police training and increased awareness of the dangers of restraint that these tragic deaths can be prevented.

References

1. Office H (1996) Consolidated circular on crime and kindred matters 35/86. Her Majesty's Sationery Office, London
2. Grant JR, Southall PE, Fowler DR, Mealey J, Thomas EJ, Kinlock TW (2007) Deaths in custody: a historical appraoch. J Forensic Sci 52(5):1177–1181
3. Inquest (2010) Deaths in Police Custody (England & Wales). http://inquest/gn/apc.org
4. Australian Institute of Criminology (2007) Deaths in custody in Australia. http://www.aic.gov.au. Accessed May 2009
5. Matthews P, Foreman J (eds) (1993) Jervis on coroners. Sweet & Maxwell, London
6. Home Office (1969) Circular No 35 of 1969. HMSO, London
7. Dalton V (1998) Australian deaths in custody & custody – related police operations 1997–98. http://www.aic.gov.au
8. http://iapdeathsincustody.independent.gov.uk
9. www.ipcc.og.uk
10. Death in Custody Working Group of the Community-Police Consultative Group for Lambeth (1996) Lessons from tragedies. Deaths in Custody in the Metropolitan Police District 1986–95
11. Davies MJ, Robertson WB (1975) Diseases of the coronary arteries. In: Pomerance A, Davies MJ (eds) The pathology of the heart. Blackwell Scientific, Oxford, pp 81–126
12. OPCS (2005) Mortality statistics (cause) (DH2 No35). The Stationery Office, London
13. Burn J, Camm J, Davies MJ et al (1997) The phenotype/genotype relation and the current status of genetic screening in hypertrophic cardiomyopathy. Marfan syndrome and long QT syndrome. Heart 78:110–116
14. Berry CL (1992) Arteritis. In: McGee JO, Isaacson PG, Wright NA (eds) Oxford textbook of pathology. Oxford University Press, Oxford, pp 842–852
15. Royal College of General Practitioners (1977) Mortality among oral contraceptive users. Lancet i:727–731
16. Saukko P, Knight B (2004) Forensic pathology, 3rd edn. Arnold, London
17. Heide S, Henn V, Kleiber M, Dressler J (2010) An avoidable death in police custody? Am J Forensic Med Pathol 31(3):261–263
18. Havis S, Best D (2003) Drug-related deaths in police custody. Police Complaints Authority, London
19. Reay DT, Holloway GA (1982) Changes in carotid blood flow produced by neck compression. Am J Forensic Med Pathol 3:199–202
20. Mercy JA, Heath CW, Rosenberg ML (1990) Mortality associated with the use of upper-body control holds by police. Violence Vict 5:215–222
21. Koiwai EK (1987) Deaths allegedly caused by the use of "choke holds" (shime-waza). J Forensic Sci 32:419–432
22. Vanezis P (1989) Techniques of examination. In: Pathology of neck injury. Butterworths, London, pp 22–27

23. Sauvageau A, LaHarpe R, Geberth V et al (2010) Agonal sequences in eight filmed hangings: analysis of respiratory and movement responses to asphyxia by hanging. J Forensic Sci 55(5):1278–1281
24. Bell LV (1849) On a form of disease resembling mania and fever. Am J Insanity 6:97
25. Billig O, Freeman WT (1944) Fatal catatonia. Am J Psychiatry 100:633–638
26. Karch SB (2008) Cocaine. In: Karch's pathology of drug abuse, 4th edn. CRC Press, Boca Raton
27. Shulack NR (1944) Sudden exhaustive death in excited patients. Psychiatr Q 18:3
28. Kraines SH (1934) Bell's mania. Am J Psychiatry 91:29
29. O'Halloran RL, Lewman LV (1993) Restraint asphyxiation in excited delirium [see comments]. Am J Forensic Med Pathol 14:289–295
30. Otahbachi M, Bagdure S, Nugent K (2010) Excited delerium, restraints and unexpected death: a review of pathogenesis. Am J Forensic Med Pathol 31(2):107–112
31. Leigh A, Johnson G, Ingram A (1998) Deaths in police custody – learning the lessons. Home Office, London
32. Morewood TCG (1998) In Custody restraint deaths. MSc Thesis, University of London
33. Bell MD, Rao VJ, Welti CV (1992) Positional asphyxiation in adults: a series of 30 cases from the Dade and Broward County, Florida medical examiners offices from 1982 to 1990. Am J Forensic Med Pathol 13:101–107
34. Reay DT, Howard JD, Fligner CL, Ward RJ (1998) Effects of positional restraint on oxygen saturation and heart rate following exercise. Am J Forensic Med Pathol 9:16–18
35. Reay DT, Fligner CL, Stilwell AD, Arnold J (1992) Positional asphyxia during law enforcement transport. Am J Forensic Med Pathol 13:90–97
36. Chan TC, Vilka GM, Neuman T, Clausen JL (1997) Restraint position and positional asphyxia. Ann Emerg Med 30:578–586
37. Roeggla M, Wagner A, Muellner M et al (1997) Cardiorespiratory consequences to hobble restraint. Wien Klin Wochenschr 109:359–361
38. Cary NRB, Roberts CA, Cummin ARC, Adams L (2000) The effect of simulated restraint in the prone position on cardiorespiratory function following exercise in humans. J Physiol 525P:31P
39. Cummin ARC, Roberts CA, Cary NRB, Adams L (2000) The effect of breath holding on arterial oxygen saturation following exercise in man. J Physiol 525P:31P
40. Hood IC, Ryan D, Spitz WU (1998) Resuscitation and petechiae. Am J Forensic Med Pathol 9:35–37
41. Rao VJ, Welti CV (1988) The forensic significance of conjunctival petechiae. Am J Forensic Med Pathol 9:32–34
42. Mash DC, Duque L, Pablo J, Qin Y, Adi N, Hearn WL, Karch SB, Druid H, Welti CV (2009) Brain biomarkers for identifying excited delirium as a cause of death. Forensic Sci Int 190(1–3):13–19

Chapter 14
Traffic Medicine

Ian F. Wall and Steven B. Karch

Introduction

Driving a motor vehicle is a complex task requiring a reasonable level of physical fitness, accurate perception, and appropriate judgment. All these factors can be affected by drugs and alcohol, greatly increasing the risk of accidents. Many medical conditions (and their treatments) may impair fitness to drive and will first be considered.

Medical Aspects of Fitness to Drive

Licensing requirements depend on the type of vehicle driven, with more stringent requirements for commercial purposes and multiaxle vehicles. In many jurisdictions, including Canada and the United Kingdom, it is the motorist's responsibility to inform the licensing authority of any relevant medical conditions. Similar requirements generally apply in the United States, except that six states (California, Delaware, Nevada, New Jersey, Oregon, and Pennsylvania) actually require physicians to report patients with seizures (and other conditions that may alter levels of consciousness) to the department of motor vehicles [1]. Similarly in two states in Australia (South Australia and the Northern Territory), reporting of patients with seizures is compulsory and there are penalties for doctors not reporting [2]. Drivers themselves have a legal responsibility to inform the licensing authority of any injury or medical condition that affects their driving ability, and physicians should take

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great pains to explain this obligation. Occasionally, especially when dealing with patients suffering from dementia, ethical responsibilities may require doctors to breach confidentiality and notify patients against their will or without their knowledge [3]; this situation will be considered later.

Requirements vary in different countries and in different jurisdictions within the same country. When in doubt about the appropriate course of action, physicians should consult the appropriate guidelines. In the United Kingdom, the Driver and Vehicle Licensing Agency (DVLA) has made available the At a Glance Guide to the Current Medical Standards of Fitness to Drive [4]. In Australia, the Austroads Guidelines for Assessing Fitness to Drive provides similar information [2]. In the European Union, where EC directives have developed basic standards but allow different countries to impose more stringent requirements, there is still considerable variation from country to country. The situation is even more complicated in the United States, where each state sets its own rules, and where Federal regulations for commercial vehicles apply as well. Often, much of the required regulatory information can be acquired via the internet, or from organizations and foundations representing patients who have the particular disease in question.

It should be assumed that all adults drive; drivers with disabilities should be given special consideration and may require modification of their vehicle or have certain personal restrictions applied.

Cardiovascular Diseases

A number of studies have demonstrated that natural deaths at the wheel are fairly uncommon and that the risk for other persons is not significant [5, 6]. Even so, requirements for commercial drivers are generally much more rigid than for individuals, and in the United States, the Federal Highway Administration prohibits drivers with angina or recent infarction from driving. The length of prohibition varies from state to state. Restrictions for noncommercial car driving, after first acute myocardial infarction, are 4 weeks in United Kingdom (though only 1 week if treated by coronary angioplasty), but only 2 weeks in Australia. In the United States, they are entirely at the discretion of the individual physician. In general, myocardial ischemia itself is not considered an absolute driving disqualification, provided treadmill stress testing demonstrates that moderate reserves are present [7]. Similarly, individuals with controlled hypertension are usually considered fit to drive, although physicians, no matter what country they are in, must give serious thought to just what sort of medication is used to control hypertension; clonidine, methyldopa, reserpine, and prazosin can produce somnolence and/or impair reflex responses.

Patients with dysrhythmias, treated with medication or with the implantation of a defibrillator/pacemaker, present a special set of problems [8]. The tendency in the United States has been to treat such individuals as if they were epileptics, i.e., individuals with the potential to lose consciousness at the wheel. Even then, the distinction is not absolute, as some individuals with implanted devices are at much higher risk for syncope than others [9], and the ultimate decision remains that of the attending physician.

Most states set minimum requirements for arrhythmia-free periods. Until fairly recently, that period was 6 months in a majority of jurisdictions, but is increasingly being shortened to 3 months in many locations. In the UK, patients with implantable cardioverter defibrillators are permanently barred from holding a group 2 license, but may hold a group 1 license providing the device has been implanted for 6 months and has not administered therapy (shock and/or symptomatic antitachycardia pacing) [4].

Epilepsy

Epilepsy is the commonest cause of collapse at the wheel, accounting for approximately 30% of such incidents. In the United Kingdom, epilepsy is a Prescribed Disability (along with severe mental impairment, sudden attacks of disabling giddiness, and inability to meet eyesight requirements), and car driving is not allowed for at least 1 year after a seizure. Here too, restrictions vary from country to country. All 50 of the United States restrict the licenses of epileptics if their seizures are not well controlled by medication. Most states require a 6-month seizure-free period and a physician's statement confirming that the individual's seizures have, in fact, been controlled and that the individual in question poses no risk to public safety. The letter from the physician is then reviewed by a medical advisory board, which may or may not issue a license. In the United States, even if the patient, at some later date, does have a seizure and cause an accident, the physician's act of writing to the board protects him or her from liability under American law, provided the letter was written in good faith.

Withdrawal of antiepileptic medication is associated with a risk of seizure recurrence. One study showed that 41% of patients who stopped treatment slowly developed a recurrence of seizures within 2 years compared with only 22% of patients who continued treatment [10]. The legal consequences of discontinuing medication, without a physician's order, can be quite devastating. Patients who stop taking antiseizure medication of their own volition and then cause an accident may face future civil liability and possibly even criminal charges if they cause physical injury [11]. Of course, rules vary from country to country, but, in general, a seizure patient who does not inform the appropriate regulatory agency may face dire consequences (including even the legitimate refusal of the insurance carrier to pay for damages).

Diabetes

Diabetes-related hypoglycemia may lead to confusion or loss of consciousness, or from complications of the disease itself, e.g., retinopathy causing visual problems or peripheral vascular disease causing limb disabilities. In January 1998, the British government introduced new restrictions on the licensing of people with insulin-dependent diabetes [12]. These restrictions were based on the second EU driver-licensing directive (91/4389), and under most interpretations of the law, they prevent insulin-treated diabetics from driving light goods and small passenger-carrying vehicles. In response to concerns expressed by the diabetic community in Britain, the British Diabetic Association commissioned a report that found little evidence to support the new legislation. Regulations were therefore changed in April 2001 to allow "exceptional case" drivers to apply to retain their entitlement to drive class C1 vehicles (3,500–7,500 kg lorries) subject to annual medical examination.

In the United States, the situation varies from state to state, but in many states diabetics are subject to restrictive licensing policies that bar them from driving certain types of motor vehicles [13, 14]. The risk of hypoglycemia, however, differs greatly among insulin-requiring diabetics, and today most insulin-dependent diabetics use self-monitoring devices to warn them when their blood glucose levels are becoming too low. Thus, a number of states have dropped blanket restrictions and allow for case-by-case evaluations to determine medical qualifications for diabetics. In some states, physicians are specifically required to notify authorities of the patient's diabetic conditions, but in all states it is the patient's responsibility to do so. As with seizure patients, failure to notify may expose the patient to both civil and criminal liability.

Vision and Eye Disorders

The two most important aspects of vision in relation to driving are visual acuity and visual fields. Visual acuity may simply be defined as the best obtainable vision with or without spectacles or contact lenses. Most countries require a binocular visual acuity greater than 6/12 for licensing purposes. In the United Kingdom, the eyesight requirements are to read a car number registration plate at 20.5 m, which corresponds to between 6/9 and 6/12 on the Snellen chart. The minimum field of vision for safe driving is generally regarded as at least 120° on the horizontal when measured with a Goldman IV4e target or its equivalent [15].

Ethical Considerations

While it is generally a patient's responsibility to inform the licensing authority of any injury or medical condition that affects their driving, occasionally ethical responsibilities may require a doctor to inform the licensing authorities of a particular problem. If a patient has a medical condition that renders them unfit to drive, the doctor should make sure the patient understands that the condition may impair their ability to drive. If the patient is incapable of understanding this advice, e.g., due to dementia, the doctor should inform the licensing authority immediately [16].

If patients continue to drive when they are not fit to do so, the doctor should make every reasonable effort to persuade them to stop, which may include informing their next of kin. If this still does not persuade the patient to stop driving, the doctor should disclose relevant medical information immediately, in confidence, to the medical adviser of the licensing authority. Before disclosing this information, the doctor should inform the patient of the decision to do so, and once the licensing authority has been informed, the doctor should also write to the patient to confirm that disclosure has been made [16].

Alcohol and Driving

Metabolism of Alcohol

Alcohol is absorbed through the stomach and duodenum. Absorption is dependent on many factors, including sex and weight of the individual, duration of drinking, nature of the drink, and presence of food in the stomach. Alcohol dehydrogenase in the gastric mucosa may contribute substantially to alcohol metabolism (gastric first-pass metabolism), but this effect is generally only evident with low doses and after eating. Studies of alcohol dehydrogenase activity in gastric biopsies of women suggest a significant decrease in activity in women compared with men, which could explain why women have higher peak blood alcohol levels and are more susceptible to liver damage after consumption of smaller quantities of alcohol when compared with men [17]. Further details of alcohol metabolism are given in Chapter 8. Once absorbed, alcohol is eliminated at a fairly constant rate, with 90% being metabolized in the liver and the remainder excreted unchanged in urine, breath, and sweat. The rate of elimination in moderate drinkers may vary between 10 and 20 mg/100 mL blood/h, with a mean of 15 mg/100 mL blood/h. Chronic alcoholics, undergoing detoxification, have elimination rates of 19 mg/100 mL blood/h or even higher [18]. This increased rate of alcohol burn off is thought to be a consequence of increased activity of hepatic microsomal enzymes (P450IIE).

Effects of Alcohol on Performance

Alcohol affects mood and behavior, causing euphoria (which is particularly significant in risk taking), but it also produces the central nervous system depression. Even at low doses, there is clear evidence that alcohol impairs performance, especially as the faculties that are most sensitive to alcohol are those most important to driving, namely complex perceptual mechanisms and states of divided attention. In a review of over 200 papers [19], a variety of behavioral aspects were examined including reaction time, tracking, concentrated attention, divided attention, information processing, visual function, perception, psychomotor performance, and driver performance. Most of the studies showed impairment at 70 mg/100 mL blood, but approximately 20% showed impairment at concentrations between 10 and 40 mg/100 mL blood.

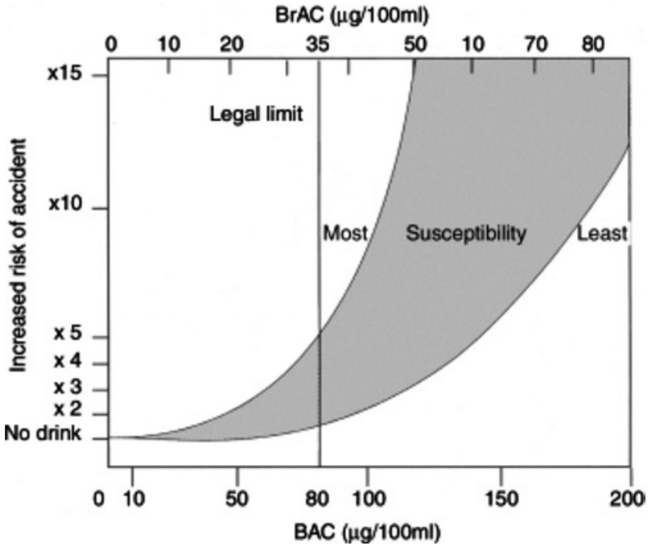

Fig. 14.1 Risk of road traffic accidents related to level of alcohol in the blood and breath. *BAC* blood alcohol concentration; *BrAC* breath alcohol concentration. Permission by Greenwich Medical Media

The definitive study on the relationship between risk of accident and blood alcohol concentration (BAC) was performed in the 1960s in Grand Rapids, Michigan by Borkenstein and Dale [20]; data were collected on 5,895 drivers involved in accidents and on 7,590 drivers not involved. Comparison of the two groups disclosed that an accident was statistically more likely at blood alcohol levels greater than 80 mg/100 mL blood, with accidents occurring more frequently as follows:

Blood alcohol (mg/100 mL)	Accident occurrence
50–100	1.5 times as frequently
100–150	4 times as frequently
Over 150	18 times as frequently

Further analysis of the data by Allsop [21] quantified the risks for different ages and different drinking habits. On average, the risk doubles at 80 mg/100 mL, increasing sharply to a 10-times risk multiplier at 150 mg/100 mL and a 20-times risk multiplier at 200 mg/100 mL blood. For inexperienced drivers and infrequent drinkers, the sharp increase occurs at much lower levels, whereas for the more experienced drinking driver it may not occur until 100 mg/100 mL (Fig. 14.1).

This research contributed to some countries lowering the allowable BAC for legal driving and in Australia, Canada, as well as most of the United States, different concentrations and rules are applied for younger and/or inexperienced drivers. As an example, most states in Australia require a zero alcohol level for probationary drivers during their first 3 years of licensing. Further evidence of the relationship between crash risk and blood alcohol levels has been shown by Compton et al. [22] who studied drivers in California and Florida. This research, surveying a total of 14,985 drivers, produced results that were in agreement with previous studies in showing increasing relative risk as blood alcohol levels increase, with an accelerated rise at levels in excess of 100 mg/100 mL blood. However, after adjustments for missing data (hit-and-run drivers, refusals, etc.), the result was an even more dramatic rise in risk, with the relative risk of crash involvement being significantly elevated at blood alcohol levels of 40 mg/100 mL.

Road Traffic Legislation

In the United Kingdom, this research led to the introduction of the Road Safety Act 1967, which set a legal driving limit of 80 mg/100 mL of blood (or 35 μg/100 mL of breath or 107 mg/100 mL of urine). This law also allows mandatory roadside screening tests and requires the provision of blood or urine tests at police stations. The Transport Act 1981 provided that quantitative breath tests, performed with approved devices, could be used as the sole evidence of drunk driving. Although the level for U.K. drivers is set at 80 mg/100 mL of blood, in practice drivers are not usually prosecuted at blood levels below 87 mg/100 mL of blood because, during the analysis, a series of results by gas chromatography (which must fall within 3 standard deviations (or 6%) of each other) is averaged, and then 6% (or 6 mg below 100 g/100 mL) is deducted from the result, which is then reported as not less than × mg/100 mL of blood.

In the United States, permissible blood levels vary from state to state and also by age. Many states have enacted "zero tolerance" laws, and the detection of any alcohol in an individual younger than age 21 is grounds for license revocation. Some states permit levels as high as 100 mg/100 mL, but most enforce the same limit as in the United Kingdom, and legislation to reduce the 80 mg/100 mL level further is under consideration. Repeated attempts to introduce one nationwide level have been rebuffed by the U.S. Congress.

Equivalent Limits in Other Body Fluids

Statutes have been used to establish BAC equivalents in other tissues and breath. Not infrequently, alcohol concentrations will be measured in accident victims taken for treatment at trauma centers. However, there are two very important differences between alcohol measurements made in hospitals and those made in forensic laboratories; first, in hospitals, standard international units (SI) are the norm, the mole is the unit of mass, the liter is the unit of volume, and alcohol concentrations are reported in mmol/L. In forensic laboratories, results are expressed as gram/deciliter or liter, or even milligrams per milliliter, and measurements are made in whole blood, not serum or plasma. Because 1 mL of whole blood weighs, on average, 1.055 g, a BAC of 100 mg/dL is actually the same as 95 mg/100 g or 21.7 mmol/L [18].

There is another, even more important, difference between serum/plasma and whole blood. The former contains 91.8% water, while the latter contains only 80.1% water. Because alcohol has a very large volume of distribution, this difference in water content means that alcohol concentrations measured in serum/plasma will be higher than concentrations measured in whole blood by approximately 14%. In practice, if plasma alcohol concentrations are to be introduced as evidence, they should be related back to whole blood concentrations using an even higher ratio (1.22:1), which corresponds to the mean value, ±2 standard deviations. As mentioned earlier, if whole blood is tested, drivers are not usually prosecuted at blood levels below 87 mg/100 mL of blood [18].

Breath testing is equally problematic. The instruments used are calibrated to estimate the concentrations of alcohol in whole blood, not plasma or serum. To estimate the serum or plasma alcohol concentration from breath measurements, a plasma/breath ratio of 2,600:1 must be used (because, as explained above, whole blood contains 14% less alcohol!). In Europe, but not necessarily in the United States, two specimens of breath are taken for analysis, and the specimen with the lower proportion of alcohol should be used as evidence.

Bladder urine, because it contains alcohol (or other drugs) that may have accumulated over a long period, is generally not considered a suitable specimen for forensic testing, especially since the presence of alcohol in the urine only proves that alcohol is present in the body. Alcohol concentrations in bladder urine cannot be used to infer the blood levels reliably. Even so, U.K. legislation and most U.S. states still allow drivers the option of providing breath, blood, or urine specimens, but as of 1999, the State of California has dropped the option of providing urine samples, and other states are considering similar actions. Under the new California provisions, police can still request a urine test if a suspect's breath test is negative [23].

Other options are available in the case of alcohol-related fatalities. Comparison of alcohol concentrations in vitreous and blood can provide a good indication of whether concentrations were rising or falling at the time of death (alcohol is distributed mainly in water and the water content of vitreous is lower than that of blood). Urine obtained from the kidney pelvis can also be used, since its alcohol content can be precisely related to blood concentration [24].

Legal Limits in Other Jurisdictions

Table 14.1 shows permissible alcohol limits for various countries. All figures are the maximum permissible amount in milligrams per 100 mL of blood (in the United States, referred to as deciliters and abbreviated dL). Although legislation has been introduced to enforce uniform standards, these standards have not been enacted, and in the United States, permissible alcohol levels vary from state to state.

Table 14.1 Prescribed blood alcohol levels in various jurisdictions

Australia	50	France	50	Poland	20
Austria	80	Germany	80	Romania	0
Belgium	80	Greece	50	Russia	0
Bulgaria	0	Hungary	0	Sweden	20
Canada	80	Italy	80	Spain	80
Czechoslovakia	80	Luxembourg	80	Turkey	0
Denmark	80	Netherlands	50	United States	100[a]
Ireland	80	Norway	50	Yugoslavia	50
Finland	50				

[a]Some states in the United States have reduced the legal level to 80 mg/100 mL of blood

Countermeasures

A number of measures have already been taken to discourage drivers from drinking, and they have had a considerable degree of success.

Lowering the Legal Limit

When the legal limit was reduced in Sweden from 50 to 20 mg, there was a fall in casualties [25]. It has been estimated that a similar reduction in the United Kingdom would save 50 lives, prevent 250 serious injuries, and eliminate another 1,200 slight injuries each year. In 1998, a cost/benefit analysis suggested that this would save £75 million a year [26]. However, the UK Government decided not to implement this reduction, though in early 2010 they have undertaken a further review of the legal limit – cost benefit savings are now expected to be £120 million – a decision is awaited.

Widening Police Breath Testing Powers

At present, in the United Kingdom, a police officer may stop any person driving a motor vehicle on the road, but that does not necessarily mean that the officer can administer a breath test. As is the case in the United States, police officers can require a breath test only if there is reasonable cause to suspect that the person detained has alcohol in their body, has committed a moving traffic offense, or has been involved in an accident.

In Finland, random breath testing along with a legal limit of 50 mg/100 mL of blood was introduced in 1977; highly visible check points are established, and typically, 8–12 policemen with breath alcohol screening devices are placed along the center of the road, the sites being chosen so that it is impossible for a driver to avoid being tested. All drivers are tested except those of emergency vehicles.

The procedure takes only seconds to perform, the system receives general public support [27], and it has resulted in a marked reduction in the number of accidents and injuries.

In the state of Victoria, Australia, "booze buses" are set up along with a roadblock – any driver who fails a roadside breath test is taken into the bus and given an evidentiary breath test (Drager 7,100 machine). Every driver in Victoria is said to be tested on average at least once a year [28].

Ignition Interlocks for Repeat Drink-Drive Offenders

These devices prevent the car ignition from being started unless the concentration of breath alcohol blown into the device is below a predetermined level, often well below the legal limit. Thereafter, during the journey, the driver is required to undertake random rolling retests. A failure of these tests activates the vehicle's lights and horn. These devices have been used in several states of the United States and also in Alberta, Canada. They are generally applied to repeat offenders, either as an alternative to disqualification or in succession to a period of disqualification. Results in the United States have shown that repeat offenses occur rapidly once the restriction is removed [29]. However, in Alberta, where there is closer supervision of the program, supplemented by counseling, more long-term improvements have been experienced. Though they are currently not the subject of any legal penalty in the United Kingdom, interlock devices can be purchased on a private basis.

High-Risk Offender Scheme

A special program in England, Wales, and Scotland was introduced in 1983, and the criteria widened in 1990 to cover drivers who were convicted of having a BAC in excess of 200 mg/100 mL blood, or refusing to provide an evidential specimen, or two offenses involving BACs in excess of 80 mg/100 mL blood within a 10-year period. This group accounts for about 30–40% of drunk driving offenders in Britain. To regain their licenses at the end of a period of disqualification, the drivers must undergo a medical examination (including blood tests to discover biochemical evidence of excessive alcohol consumption) to demonstrate with reasonable certainty that they are not alcohol abusers [4]. Similar statutes apply in the United States. In California, drivers found to have a BAC greater than 200 mg/100 mL, in addition to whatever other sanctions are imposed, are required to attend a 6-month educational program [23]. In the United States, penalties for drunk driving may be "enhanced" under special circumstances, such as a second conviction for drunk driving, or speeding at the time of arrest, or the presence of a child in the car, or the causation of property damage or injury.

Procedural Issues

While the procedures involved may seem very simple, numerous technical defenses have been raised in most countries around the world. Not surprisingly, many of these challenges are very similar, no matter the country in which they are offered. Challenges to the U.K. Road Traffic Act are illustrative of the problem.

Definitions

Section 5(1) of the Road Traffic Act 1988 (subsequently referred to as RTA) states that: if a person drives or attempts to drive a motor vehicle on a road or other public place, or is in charge of a motor vehicle on a road or other public place, after consuming so much alcohol that the proportion of it in his or her breath, blood, or urine exceeds the prescribed limit, he or she is guilty of an offense. Unfortunately, the word "drive" is not actually defined, but in fact, three points need to be proved: first, that the person is in the driving seat or has control of the steering; second, that the person charged must have something to do with the propulsion of the vehicle; and finally, that what the individual was doing must fall within the normal meaning of driving.

Attempting to drive has produced an abundance of case law, but it has been held that acts of mere preparation, e.g., checking the engine, finding keys, or opening the car door, do not amount to attempting to drive but steps on the way to what would have been driving, if not interrupted, may amount to an attempt, e.g., putting the key in the ignition. However, in a test case in the UK, when police found a man asleep in his van with the doors locked while over the legal limit, judges ruled by a majority decision that the laws that led to his conviction were "disproportionate" and "violated the presumption of innocence" to which he was entitled under Article 6(2) of the European Convention on Human Rights [30].

In Section 185(1) of the RTA, a motor vehicle is defined as a "mechanically propelled vehicle intended or adapted for use on a road" – the words "mechanically propelled" are intended to have a very wide meaning and will cover any transmission of power from the engine to the wheels by mechanical means. Similar regulations are to be found throughout the EU, and if further evidence is needed as to just how vague the definition of "mechanically propelled" may be, one needs only to consider the arrest, in 1997, of a paraplegic Scandinavian who was arrested (and tried) for unsafe driving of his wheelchair.

In Section 192(1) of the RTA, the word "road" is defined as any highway and any other road to which the public has access and includes bridges over which a road passes. Public place is a question of fact for the court to determine. In English law, a car park attached to a public house was held, during opening hours, to be a public place as it was attached to a tavern that offered its services to all members of the public, whereas the same car park would not be regarded as a public place if it were attached to a private club [31].

"In charge" is a question of fact, not law. As a general rule, the person remains in charge until he or she takes the vehicle off the road unless some intervening act occurs, e.g., handing keys to another person prevents him or her from retaining control. There is a statutory defense in that a person shall be deemed not to be in charge if he or she can prove that, at the time, the circumstances were such that there was no likelihood of his or her driving the vehicle while the proportion of alcohol in the blood was over the prescribed limit. The fact that the driver was injured or that the vehicle was damaged may be disregarded by the court if it is put forward as a defense. The court is therefore entitled to consider what the position would have been had the defendant not been prevented from driving by damage or injury. Of course, the state must always prove that the defendant was actually driving the car. That may prove difficult if, as is the case in many accidents, there are no witnesses.

Breath Testing

Section 6(1) of the RTA conferred the power to require a breath test only to officers in uniform. The courts have already ruled against a challenge where the officer was not wearing his helmet [32]. In the United Kingdom, the breath test may be taken either at or near the place where the officer makes a request for one. Normally, that would be at the roadside, but not necessarily at the scene of the offense. If an accident occurs owing to the presence of a motor vehicle on a road or other public place, a police officer may require any person who he or she has reasonable cause to believe was driving or attempting to drive, or in charge of the vehicle at the time of the accident, to provide a specimen of breath for a breath test. The test may be taken at or near the place where the requirement was made or, if the police officer thinks fit, at a police station specified by the officer. In the United States, roadside breath testing, with nonevidentiary screening devices, is permitted only in "zero tolerance" states, with drivers under age 21 years.

In the United Kingdom, a person failing to provide a specimen of breath without reasonable excuse is guilty of an offense. A reasonable excuse would include someone who is physically or mentally unable to provide a sample, or if the act of providing the sample would, in some way entail risk to health. In most U.S. states, refusal to submit to a breath (or blood or urine) test is admissible as evidence in criminal proceedings, and as a rule, leads to license suspension, even if guilt is not proved in court. In some states, refusal is actually considered a separate crime. This somewhat strange situation comes about because most U.S. states, and most other countries, have per se laws for alcohol: an alcohol level above some preset limit is, by law, proof of intoxication [33, 34].

Section 6 of the RTA allows police officers to arrest a driver without a warrant if the breath test is positive, or if the driver fails or refuses to provide a specimen of breath, and the officer has reasonable cause to suspect alcohol in his or her body. Additionally, if an accident occurs owing to the presence of a motor vehicle on a road or public place, and a police officer reasonably suspects that the accident involved injury to another person, then for the purpose of requiring a breath test or arresting a person, the officer may enter (by force if need be) any place where that person is or where the officer reasonably suspects the person to be.

Hospital Procedure

In the United Kingdom, patients at a hospital do not have to produce a breath test or provide a specimen for a laboratory testing unless the practitioner in immediate charge of their case has been notified and does not object on the grounds that the requirement would be prejudicial to the proper care and treatment of the person. In the United States, forensic blood samples can be taken from unconscious patients who are not able to give informed consent. Legislative changes in the UK in the Police Reform Act 2002 give doctors similar powers with a few subtle differences in that blood can be taken providing the person has been involved in an accident, the doctor is satisfied that the person is not able to give valid consent (for whatever reason which could include mental health problems), and the person does not object to or resist the specimen being taken [35]. After death, a coroner can order that the blood alcohol level be measured (remembering always that the value measured will be 14% lower than had serum or plasma been measured at a clinical laboratory). In the United States, Medical Examiners and Coroners do not require special permission to measure ethanol (or any drug for that matter) and they do so routinely. Ethanol concentrations in vitreous humor are made and may be introduced in court. However, no fixed relationship between postmortem blood and vitreous concentrations is recognized in law. Additionally, when bodily harm has resulted, or when there is evidence of criminal activity (such as leaving the scene of an accident), then it is within the power of the officer to order that blood be drawn, even if the suspect is unwilling or unconscious.

Police Station Procedure

Police may require a suspect to provide either two breath samples, for analysis by means of an approved device, or a sample of blood or urine for laboratory testing. This is usually done at a police station, since it is almost unheard of for a hospital in the United Kingdom or the United States to be equipped with an evidentiary breath testing device. Blood or urine samples can only be collected at a police station or hospital. In the United Kingdom, such a request cannot be made at a police station unless the constable making the requirement has reasonable cause to believe that, for medical reasons, a specimen of breath cannot be provided, or at the time the requirement is made, an approved breath analysis device is not available, or not practical to use, or that the suspected offense is one under Section 3A or 4 of the RTA, and the constable making the requirement has been advised by a doctor that the condition of the person might be due to some drug. This situation does not occur in the United States where, if appropriate staff are available, both blood and urine may be obtained at the police station.

In the United Kingdom, if a specimen other than breath is required, police may demand either a urine or blood test. If blood cannot be obtained as, e.g., might well be the case in a chronic intravenous drug abuser, then a urine sample must be provided within 1 h of the request for its provision being made and after the provision of a previous specimen of urine. In the United States, urine specimens are generally not considered admissible proof of intoxication. A very large number of studies have shown that the ratio between blood alcohol and pooled urine is highly unreliable and unpredictable [36, 37]. Ureteral urine, on the other hand, has an alcohol concentration 1.3 times greater than blood [24]. Collection of ureteral urine is often attempted at autopsy, but, for obvious reasons, is not an option with living patients.

Breath samples can only be analyzed with approved devices. Those currently in use include the Intoximeter EC/IR, Camic Datamaster, Lion Intoxilyzer 6000, and Drager Alcotest 7100 (Australia). Only officers trained to use the machine are allowed to carry out the intoximeter procedure, and the lower of two readings is taken. The subject must not have smoked for 10 min or have consumed alcohol or used a mouth spray or mouthwash, taken any medication, or consumed any food for 20 min before the breath test.

If the reading is below the prescribed limit of 35 μg of alcohol per 100 mL of breath, no action is taken unless impairment through drugs is suspected. If that is the case, a forensic physician or other healthcare professional should be called. If the level is between 36 and 39, no prosecution can occur unless there is impairment. If the level is between 40 and 50, the person is given the option of having the breath sample reading replaced by a specimen of blood or urine (the statutory option), but it is for the police officer to decide which, in accordance with Section 7 above. At levels over 51, the person is charged with an offense. Different rules and regulations, but with much the same intent, apply in other countries. In 2010, the UK Government commissioned a report by Sir Peter North QC to review current drink/drugs driving legislation. In his review [38], he recommended that this statutory option should be removed.

Blood Samples

It is wise to have a standardized routine for this procedure, if only to help prevent some of the technical defenses that are frequently raised in court. RTA blood alcohol kits are available with all the necessary equipment, and similar kits are sold in the United States, although their use is not mandatory. Whether or not a kit is used, appropriate chain of custody forms must be completed, and the record must reflect that alcohol-containing swabs were not used to cleanse the skin (actually, studies have shown that alcohol swabs contribute negligibly to the final result, but the issue is routinely raised in court) [39].

The police officer should identify the doctor to the person and the doctor should obtain witnessed informed consent. The physician must then determine whether there are any medical reasons why a sample of blood cannot be taken. It is for the doctor to decide where the sample of blood is taken from. The sample should be divided equally between the two bottles and shaken to disperse the preservative. The bottles should be labeled and placed in the secure containers and caps applied. The driver is allowed to retain one sample, which is placed in an envelope and sealed. The driver is then given a list of analysts.

Under U.S. law, blood may be taken even if the driver objects, providing the driver has been involved in an accident leading to injury, or a crime has been committed. Most U.S. states have statutes that excuse hemophiliacs and patients taking anticoagulants from blood testing [23]. Under British law, a forensic physician may make up to three unsuccessful attempts at taking blood before the driver can reasonably refuse to give blood on grounds that the defendant has lost confidence in the doctor. No such protection exists in U.S. law.

Impairment Under the Road Traffic Act (Section 4)

The medical examination and procedure to be adopted when it is suspected that a person is unfit through drink or drugs will be considered later in this chapter under Section "Drugs and Driving."

Complex Defenses

Numerous technical defenses have been advocated over the years, and doctors should be aware of the most common. Failure to provide a sample of breath or blood will be considered separately.

Failure to Provide a Sample of Breath

Unless there is a reasonable excuse, failure to provide a specimen of breath, blood, or urine is an offense under Section 7 of the RTA. In the United States, refusal leads to automatic license suspension and, in some states, may actually constitute a separate crime; police are under an obligation to make sure that drivers are made aware of that fact. The motorist must understand the mandatory warning of prosecution if a specimen is not produced. Failure to understand, at least in the United Kingdom, is a reasonable excuse for the non-provision of a sample [40]. The decision as to whether there is a medical reason not to supply a sample of breath is left to the police officer and is summarized in case law. There is no provision or requirement at that stage for a doctor to be summoned or to give an opinion.

Examples of medically acceptable reasons include mouth, lip, or facial injury, tracheotomy, rib injury, and neurological problems; case law has stated that fear of AIDS not amounting to phobia [41], shock [42], and even intoxication [43] can, in certain circumstances, be regarded as reasonable excuses.

Many cases have been challenged on the basis that the person was unable to blow into the intoximeter due to respiratory problems. Research has now clarified some of these situations. Spirometry has shown that if a person has a forced expiratory volume in 1 second (FEV_1) of less than 2.0 L and a forced vital capacity (FVC) of less than 2.6 L, then that person would generally be unable to use a breath alcohol testing device [44]. A further study of healthy people of small stature (less than 166 cm tall) showed that if their FEV_1, FVC, and peak expiratory flow rate (PEFR) were greater than 2.31, 2.61, and 330 L/min, respectively, then they should be capable of supplying a suitable breath sample [45]. While these papers were particularly useful as most forensic physicians do not have access to spirometry but do have access to a simple peak flow reading in the custody situation, most of the breath testing machines that were used in the study no longer exist, the respiratory function values cannot be applied to breath testing devices in current use.

A study in Victoria, Australia, showed that persons with an FEV_1 greater than 1.51 could provide an adequate screening sample on the Lion Alcolmeter SD2 roadside screening device [46] and that, with an FEV_1 greater than 1.0 and FVC greater than 1.75, individuals were able to provide adequate samples on the Drager Alcotest 7110 (as used in Victoria) evidentiary breath testing machine.

A more recent study [47] on the current Lion Intoxilyzer 6000 concluded that some subjects with lung diseases may have difficulty in providing evidential breath samples. The study showed that 9 of the 30 patients with lung disease failed to provide an evidential sample of breath and was performed on patients who had types of lung disease at the severe end of the spectrum. Importantly, what the research also showed was that many patients had sufficient FVCs of more than 1.5 L and should, in theory, have been able to satisfy the machines' requirements of 1.2 L but still could not, in practice, provide a sample possibly because of the long periods needed for exhalation and recovery.

A recent fashionable defense is that the presence of a metal stud through a hole pierced in the tongue invalidates the breath alcohol test because of the prohibition against foreign substances in the mouth and because of the potential for the jewelry to retain alcohol and interfere with the breath test. However, experimental work has shown that the rates of elimination of mouth alcohol were no different in subjects with a tongue stud as opposed to controls and that, for the purposes of breath alcohol testing, oral jewelry should be treated the same as metallic dental work and left in place without affecting the outcome of the breath test [48].

Failure to Provide a Sample of Blood

First, there must be a definite request to provide a sample of blood. In Kuldip Singh Gill v. DPP [49], it was held that a driver could not be convicted of failing to supply a specimen of blood or urine if he or she was not requested to do so. Where the sample of blood is taken from is solely the choice of the forensic physician (or, in the United States, the emergency room physician). In Solesbury v. Pugh [50], the defendant was found guilty of failing to supply a specimen as he would only allow a sample to be taken from his big toe, which the doctor was not prepared to do.

It is reasonable for the person to request that his or her own doctor takes the sample of blood, providing this does not delay the sample being taken [51]. In the United Kingdom, if the patient's own doctor and forensic physician are both present, the person can choose which doctor took the sample. Similar rules apply in the United States, where statutes generally spell out that financial responsibility for such services rests with the driver and not the state. In the United Kingdom, and probably in the United States as well, if a sample of blood is provided but the doctor spills the sample, then the law has been complied with on the basis that removal of the syringe from the vein by the doctor completes the provision of the specimen by the defendant [52]. In the United Kingdom, a minimum of 2 mL of blood is required (the laboratory requires a minimum of 1 mL for analysis) for an adequate sample [53]. If less than this is obtained, the sample should be discarded and another one attempted or the police officer advised that there is a medical reason why a sample of blood should not be provided and the urine option can then be selected. In the United States, minimum quantities are generally not written into statute. As indicated previously, alcohol swabs should not be used. In the early 1980s, one police force purchased and used swabs containing alcohol with the result that numerous convictions were later quashed [54].

Probably, the most common defense for failure to provide a sample of blood is that of needle phobia. If this is alleged, a full medical history should be obtained and enquiry made of whether the person has had blood tests before, whether ears or other parts of the body have been pierced, or whether there have been foreign travel immunizations or any other medical or dental procedure undertaken in which an injection may have been administered. Specific enquiry about the phobia should be made. British appellate judges [55] have stated that "no fear short of phobia recognized by medical science to be as strong and as inhibiting as, for instance, claustrophobia can be allowed to excuse failure to provide a specimen for a laboratory test, and in most if not all cases where the fear of providing it is claimed to be invincible the claim will have to be supported by medical evidence." Stark and Brener [56] stress the importance of having a standardized approach for assessing needle phobia using diagnostic guidelines for a definite diagnosis of a specific phobia and wisely conclude that the best way to ensure a successful prosecution is to obtain a sample, any sample for analysis! Rix [57] also gives some very practical advice to forensic physicians: be able to distinguish between repugnance and phobia, be able to distinguish between unwillingness and inability, document the history and examination with emphasis on the presence or absence of signs of anxiety, and be sure the decision is based on firm medical evidence. Finally, record all these information, specifically note in the police record whether or not a medical condition has been identified, and then communicate this opinion to the police officers verbally.

Another common defense is that of consuming alcohol after the offense – the hip flask defense [58]. It is used almost universally and is based on the fact that while it is unlawful to have an excessive BAC at the time of driving, it is not unlawful to have an elevated blood alcohol at the time of being tested. In the United Kingdom, Section 15(3) of the RTA allows for a driver to prove that he or she had imbibed alcohol after ceasing to drive and that the amount of such consumption was the sole reason for being over the legal limit or unfit to drive, at the time he or she gave a sample for analysis. It will be necessary for a scientist to prove that it was only the postdriving consumption that caused the analysis to reveal an alcohol level above the prescribed limit. The quantity of alcohol in the after-drink, the time of intake, and the age, sex, height, and body weight of the driver can all be used to calculate the theoretical expected BAC [59]. Back calculations can only ever be approximate as they are based on average values and while they are reasonable estimates for most people, they may, on occasions, fail to reflect accurately the situation of a particular individual, regardless of whether the calculation is for pre- or postincident drinking. There are now computer programmes available to calculate these levels.

But the lengths a person may go to in order to avoid a conviction is illustrated by the case of Mukandiwa [60] who alleged he could not give a blood sample for spiritual reasons. He was registered as a member of the Zimbabwe National Traditional Healers Association, known as Zinatha, and was authorized to practice healing using both traditional and ritual healing. He was a spirit medium, known as a Mhondoro and, as such, had to avoid situations that drove him into a trance. The sight of blood was one such situation. The sight of blood may, he claimed, cause him to go into a trance and become violent, thereby creating serious risk of injury to his health and to others in the police station. This was held to be a reasonable excuse but subsequently overturned in the High Court, on the basis that the defendant could have looked away or closed his eyes!

Failure to Provide a Sample of Urine

If a woman is requested to provide a sample of urine, it is important to have a female officer present as it has been held that because of the embarrassment that it could involve, the refusal to supply a sample of urine could be regarded as a reasonable excuse [61]. Any embarrassment at having to urinate in front of an officer of the same sex is not regarded as a reasonable excuse for not having supplied a specimen. However, in order to pass urine, it is necessary to relax the bladder sphincter muscles; anxiety causes muscle tension and difficulty in micturition. Self-conscious feelings elicited when others are present may possibly interfere with the ability to relax the bladder sphincters. This is known as avoidance paruresis, sometimes called shy bladder, bashful bladder, or bladder shyness and may be implicated in a defense of failure to provide a sample of urine without reasonable excuse.

Methadone and other opiates are known to have an effect on the bladder sphincter and can thus cause delayed bladder emptying; this effect could be considered a reasonable excuse for failing to provide a urine sample [62]. In Sweden, Jones and Logan [59] reported the top ten defense challenges for driving under the influence (DUI) of alcohol (Table 14.2). This situation may be subject to some change, since medications such as

Table 14.2 Top 10 defense challenges for driving under the influence of alcohol

Drinking after the offense – the hip flask defense
Laced drinks
Inhalation of ethanol vapors from the work environment
Pathological condition or trauma
Use of skin antiseptics containing ethanol
Alleged mix-up of blood specimens
Postsampling formation of alcohols
Drug–alcohol interactions
Consumption of elixirs or health tonics containing alcohol
Infusion of blood or other liquids during surgical emergency treatment

tolterodine (Detrusitol) and other muscarinic receptor antagonists are being increasingly prescribed for treatment of patients with symptoms of an unstable bladder. This may explain why California has already dropped urine from its list of testing options.

Postmortem Alcohol Measurements

This topic has been reviewed in depth by Pounder and Jones [24]. High postmortem alcohol concentrations do not imply that impairment was evident during life. Of 32 alcoholics presented at an emergency room for medical treatment, only 23 had apparent behavioral abnormalities, 6 were confused, and 3 were drowsy, even though the mean alcohol concentration was 313 mg/100 mL (range 180–450 mg/100 mL) [63]. Alcohol can be measured in a number of tissues, but the most accurate picture is usually obtained when multiple sites are sampled, e.g., vitreous, gastric contents, blood, and urine (particularly if ureteral urine is available), and the alcohol concentrations compared.

Since the eye is anatomically isolated, putrefaction is delayed, and there is little problem with postmortem redistribution, vitreous measurements can be used to confirm values obtained from whole blood and urine, to distinguish postmortem alcohol production from antemortem ingestion, and to determine whether BACs were rising or falling at the time of death. Vitreous contains more water than blood so that the blood/vitreous alcohol ratio is less than 1. Ratios greater than 1 suggest that death occurred before equilibrium had been reached, i.e., blood alcohol was still rising [64]. Vitreous alcohol concentrations can be related to blood concentrations; however, there is so much intraindividual variation that extrapolation in an individual case is probably unwise and unsound scientifically.

As previously mentioned, serum and plasma contain more water than whole blood, and it follows that the alcohol content of the former will be 10–15% higher than the latter. Since postmortem measurements are made with whole blood, and since the water content of the cadaver begins to decrease almost immediately after death, estimating antemortem values with any precision is difficult, especially if only blood has been sampled. However, if samples from multiple sites are obtained, and vitreous, blood, and urine (urine as it is being formed contains 1.3 times as much alcohol as whole blood) are all analyzed, it may be possible to make a reasonable estimate of what the alcohol concentration was at the time of death [24].

Drugs and Driving

The Problem

Increasing alcohol levels are associated with increased risk of accidents, but fatigue, drug abuse, and even the use of prescription medication can also increase risk [65]. The danger associated with sedatives and hypnotics is readily appreciated, but other drugs, such as anticholinergics, antidepressants, antihistamines, and antihypertensive medications, and even stimulants, increase risk, either by producing drowsiness or causing impairment of judgment. Patients should be warned about this and, after starting therapy, or after a significant change in dose, should avoid driving until it is known that unwanted effects do not occur [66, 67].

The Scale of the Problem

The size of the problem is not really known. In the United Kingdom in 1997, over 860,000 breath tests for alcohol were carried out with a refusal (presumed positive) rate of 12% (103,000) [68]. During that same period, the Forensic Science Service dealt with only 1,850 drugs/driving submissions. In a 2-week period in August 1996, the Forensic Science Service received 270 blood specimens for testing for driving with excess alcohol. Further examination revealed that 18% contained one or more drugs and, of those that fell below the legal alcohol limit, a further 18% were positive for drugs. If this 18% figure were applied to those 103,000 cases in 1997, over 18,000 cases would have been identified in which drivers had drugs in their body [69].

In October 1999, the U.K. Department of Environment, Transport and the Regions completed a 3-year study into the incidence of drugs in road accident fatalities [70]. There were a total of 1,138 road user fatalities including drivers, riders of two-wheeled vehicles (34 of them cyclists), passengers in vehicles, and pedestrians; over 6% tested positive for medicinal drugs, 18% for illicit drugs (mainly cannabis), and 12% for alcohol.

In this study, urine was tested by immunoassay for the following drugs: alcohol, amphetamines, methyl amphetamines (including ecstasy), cannabis, cocaine, opiates, methadone, LSD, benzodiazepines, and tricyclic antidepressants (TCAs). The incidence of medicinal drugs likely to affect driving had not significantly changed from the 1985 to 1987 study. However, illicit drug taking in drivers had

Table 14.3 Type of drug detected in samples submitted to the FSS in 1997

Amphetamine	13%	Methylamphetamine	3%
Cannabis	28%	Cocaine	6%
Opiates	16%	Methadone	7%
Benzodiazepines	24%	Others	3%

increased sixfold in percentage terms, and there was a comparable increase among passengers. In addition, an increasing number had taken more than one illicit drug. In 1997, drugs were detected in approximately 90% of samples submitted to the U.K. Forensic Science Service for analysis (Table 14.3). More recent research [71] showed that 6% of drivers aged between 17–39 in Scotland claimed to have driven at some time while under the influence of drugs and 3% in the last year.

Effects of Different Drugs

The effects on driving of different drugs will now be considered.

Cannabis

Numerous studies have been undertaken to examine the effects of cannabis on driving. One large meta-analysis of over 150 studies showed that cannabis impairs the skills important for driving, including tracking, psychomotor skills, reaction time, and performance, with the effects most marked in the first 2 h after smoking and with attention, tracking, and psychomotor skills being affected the most [72]. The study also showed that impairment is most marked in the absorption phase as opposed to the elimination phase, and that frequent cannabis users become less impaired than infrequent users. These are, for the most part, older studies, done during the 1970s. Impairment is dosage-dependent, and externally observable symptoms, e.g., impairment of psychomotor skills or the impression of absent-mindedness, disappear quickly during the early elimination phase. More recent studies [73] carried out with volunteer marijuana smokers who were actually driving found that the main effect of marijuana was to increase lateral movement of the vehicle moderately within the driving lane on a highway [74, 75]. A UK study [76] offered further support for the view that, under the influence of cannabis, users are acutely aware of their impairment, but attempted to compensate for their impairment by driving more cautiously.

The results of another very recent study [77] suggest that alcohol and marijuana-induced impairment differ in some important respects. This study compared the effects of three doses of cannabis and alcohol (placebo, low and high doses), both alone and in combination, on the driving performance of young, novice drivers, and more experienced drivers. Alcohol was administered as ethanol (95%) mixed with orange juice in doses of approximately 0, 0.4, and 0.6 g/kg. Cannabis was administered by inhalation of smoke from pre-rolled cannabis cigarettes that contained 19 mg delta-9-THC. When the simulated driving performance of 25 experienced and 22 inexperienced drivers was tested under the nine different drug conditions, high levels of cannabis generally induced greater impairment than lower levels, while alcohol at the doses used had few effects and did not produce synergistic effects when combined with cannabis. Both cannabis and alcohol were associated with increases in speed and lateral position variability; high-dose cannabis was associated with decreased mean speed, increased mean and variability in headways, and longer reaction time, while in contrast alcohol was associated with a slight increase in mean speed. Given the limitations of the study, it is of great interest to further explore the qualitative impairments in driving performance associated with cannabis and alcohol separately and how these impairments may manifest in terms of crash characteristics. These results may force some reworking of commonly accepted dogma. Finally, there is the issue of testing accuracy. Controlled experiments [78] done with chronic cannabis smokers, living in a locked metabolic ward, show without any reasonable doubt that substantial whole blood THC concentrations persist multiple days after drug discontinuation in heavy chronic cannabis users. Whether or not neurocognitive impairment actually occurs with low blood THC concentrations, and how long it takes to return to normal performance, are not known. These findings may make it impossible to set per se limits for marijuana in DUI drugs legislation.

Opiates

Single doses of narcotics can have marked effects on performance, such as reaction time. However, most studies of opiates among regular users suggest that they do not present a hazard or exist as a significant factor in driving. One study [79] compared driving ability between patients stabilized on methadone and those beginning or receiving an increased dose of methadone. A key finding appeared to be that patients on a maintenance dose have no psychomotor impairment in relation to driving ability; thus, clients on a methadone program should not be considered impaired in their ability to perform complex tasks such as driving a motor vehicle. In the United Kingdom, persons on a stable methadone program who have not abused other drugs for 1 year, and who have clear urine drug screening tests on a regular basis, are allowed to hold a driving license subject to annual review [4]. However, it should be remembered that users of heroin are also prone to heavy use of other psychoactive drugs, such as cocaine, alcohol, and tranquilizers, all dangerous when it comes to driving.

This problem is illustrated by a study [80] from Germany. Thirty-four methadone substitution patients, all of them volunteers, were subjected to a battery of psychological tests and the results compared with those of a control group. The methadone group ($n=34$) consisted of 25 men and 9 women (age range 18–38 years). Urine samples of approximately two thirds of the methadone patients tested positive for multiple drug use, the most frequent drug ($n=14$) being cannabis. On psychological testing, the methadone substitution patients achieved lower scores on almost all tests. Performance deficits were particularly conspicuous in sustained attention, sensori-motor coordination, and reaction capability. Deficits were minimal in the 12 methadone patients who were, in fact, taking only methadone. The authors conclude that, under certain conditions, long-term methadone maintenance patients under strict medical supervision do not suffer significant driving impairment, providing that no other drugs have been taken.

These finding were further emphasized in a recent paper from Norway [81], where patients enrolled in an opioid-assisted rehabilitation programme are also permitted to drive a motor vehicle. Researchers investigated drivers who had been apprehended, who had methadone in their blood. Cases of driving involving methadone alone were very rare. In most cases, benzodiazepines were found with amphetamine type drugs, the most common illegal substance, followed by cannabis derivatives. No correlation between methadone concentration as judged by the Norwegian clinical test of impairment (CTI) was seen.

Cocaine and Methamphetamine

Although the argument often goes unchallenged in court, all drugs do not, by definition, produce impairment. Even though some U.S. states define "being under the influence" as synonymous with the presence of any drug, some drugs do improve performance. In fact, low-to-moderate acute doses of cocaine and amphetamine can be expected to increase positive mood, energy, and alertness, especially in nontolerant individuals [82]. It has been known since World War II that use of d-amphetamine can increase the ability to sustain attention over prolonged periods when performing monotonous tasks. For that very reason, radar operators and pilots of both Allied and Japanese armies were issued supplies of amphetamine. Many of the performance tasks related to driving can be improved, at least in the laboratory, by treatment with stimulants [83]. Although the results of one retrospective autopsy study suggest that methamphetamine users seem more likely to be involved in traffic accidents [84], a driving simulator study [85] of young people who had taken Ecstasy (MDMA) showed that basic vehicle control is only moderately affected but risk taking is increased. It seems likely that abrupt discontinuation of either drug in a chronic user could result in driving impairment, but that situation has never been tested [74]. Very large doses can result in toxic psychosis with symptoms indistinguishable from paranoid schizophrenia, a condition that is extremely unlikely to improve driving performance.

Cocaine and methamphetamine are different drugs, even if they do share some common modes of action. There have been only a few experimental studies on the acute effects of cocaine on performance and these are mostly restricted by methodological limitations, such as the administration of low doses. For example, controlled studies of human volunteers given modest doses of cocaine (0.58 mg/kg) failed to demonstrate significant impairment [86]. In most of the studies that have been performed in relation to driving impairment, it was not possible to calculate the associated risks because the number of positive cases was too low. However, other studies [87] clearly demonstrate that drivers under the influence of cocaine are significantly more likely to be responsible for a crash than drivers who are not under the influence of this drug (2.3 OR, 95% CI: 1.4–4.0).

Recently, Musshoff and Madea [88] measured cocaine and its principle metabolite, benzoylecgonine, in the blood of German drivers arrested for driving impairment. When blood samples were collected into sodium fluoride containing tubes (which prevent cocaine breakdown), the mean cocaine concentration was 836 ng/mL while that of benzoylecgonine was 669 ng. Given the short half-life of cocaine (in the order of 1 h), concentrations measured in hundreds of milligrams prove recent ingestion, as does the simultaneous detection of both cocaine and benzoylecgonine. However, the detection of benzoylecgonine in isolation cannot be construed as proof of cocaine impairment as one would expect benzoylecgonine to remain present in the blood for more than 24 h. If impairment does occur, the duration of impairment has not been measured. Any per se legislation on cocaine-induced impairment would require the presence of actual cocaine, not any of its metabolites.

Sedative-Hypnotics

Benzodiazepines impair psychomotor performance in nontolerant individuals, generally in a dose-dependent manner. Most of the widely prescribed benzodiazepines increase lateral lane movement and slow response time to a lead car's change in speed. Several of the benzodiazepines (oxazepam 50 mg, flurazepam 30 mg, and lormetazepam 2 mg) predictably impair driving the morning after. Diazepam (15 mg) impaired performance on a clinical test for drunkenness, which comprised 13 tests assessing motor, vestibular, mental, and behavioral functioning [89, 90]. One study [91] showed a clear relationship between dose of benzodiazepines and risk of impairment, which the authors felt probably supported a limit for benzodiazepines and driving as low as within the "therapeutic range."

Acute doses of many benzodiazepines slow response time in simple or choice visual reaction time tests and impair attentional performance and cause deficits that are not due to sedation. In fact, the impairment of sustained attention and vigilance in benzodiazepine users seems to be the direct result of some, as yet uncharacterized, direct action on perceptual sensitivity [74].

Multiple Drug Use

Polydrug use is common and can result in complex interactions, with the drugs having additive, antagonistic, or overlapping effects. Alcohol is commonly consumed in addition to abused drugs. In a study on alcohol and cannabis [92], it has been shown that when they are administered together, the result was one of additive impairment. This finding was confirmed in a UK study [93]. In the laboratory setting, however, simultaneous administration of alcohol and cocaine seems to minimize alcohol-related deficits [83]. The tendency towards polydrug abuse complicates the issue of determining which drug, if any, is responsible for impairment. In the study by Musshoff cited above [88], more than 50% of those arrested had other drugs besides cocaine present.

Antidepressants

There are many side effects associated with the use of the TCAs, e.g., amitriptyline, that are relevant to the ability to drive, such as blurred vision, slow visual accommodation, disorientation, and eye-hand coordination; the most important are the induction of drowsiness, lethargy, and sedation. An analysis of 500 road traffic accidents showed that victims who had taken TCAs had a relative accident risk 2.2 times greater than non-TCA users and that patients using TCAs with a daily dose greater than or equivalent to amitriptyline 125 mg had a sixfold increase in road traffic crash risk [94]. The newer antidepressants drugs of the 5-HT reuptake inhibitor class, e.g., fluoxetine, paroxetine or the selective serotonin and noradrenaline reuptake inhibitors (e.g., venlafaxine), have been shown to not generally affect driving performance and are safe for use by patients who drive [95].

Over-the-Counter Preparations

An increasing number of drugs can now be bought over the counter from pharmacies. Many of these preparations, e.g., cough mixtures and decongestants, contain drugs that can cause sedation, particularly the older antihistamines, e.g., chlorpheniramine and diphenhydramine. The newer nonsedating antihistamines such as terfenadine and astemizole generally do not appear to impair driving. However, one study that measured driving performance across differing doses of terfenadine found that performance was impaired at very high doses (240 mg), stressing the need to establish the behavioral effects of drugs over a range of doses [96]. The second-generation group of antihistamines is less lipophilic than the previous generation and thus cross the blood–brain barrier less readily, accounting for the lower levels of sedation observed with the newer drugs. Thus, while the second-generation antihistamines generally produce less sedation than first-generation compounds, if therapeutic doses are exceeded, the so-called nonsedating antihistamines become sedating and can impair driving.

Assessment in the Field by Police

In the United Kingdom, if a police officer stops a driver, for whatever reason, and feels the driver is unfit to drive, it is highly likely that a roadside breath test will be carried out. That is not the case in the United States, where field breath testing is only permitted in some states, and then only for drivers under the age of 21 [23]. The laws of the United States also prevent random breath testing. Under the Fourth Amendment, searches and seizures must be reasonable. Stopping a vehicle is a seizure, but it may be construed as reasonable if the police officer has a justifiable suspicion that an offense is being committed. The procedures American officers follow in DUI cases are surprisingly similar to the procedures under the United Kingdom Section 4 RTA. To gain powers to carry out further tests, officers in most U.S. states first have to be satisfied that the driver is impaired. This then gives them the probable cause to carry out subsequent tests similar to the Section 4 procedure to prove impairment. It is quite possible that some of the newer technologies might be applied in the field to drugs other than alcohol. However, concentrations of THC and THC-COOH in oral fluid show a large variation and there is no correlation between oral fluid and urine samples from cannabis abusers. Thus, detailed information about time interval between drug use and sample collection is needed to interpret the oral fluid results properly, and the value of testing saliva has yet to be convincingly demonstrated [97].

If breath testing is negative, impairment due to drugs or medical illness must be considered. It was previously the case that in the United Kingdom, police traffic officers received little or no training in the recognition of signs and symptoms of drug effects. However, a pilot study [98] was carried out in England, Wales, and Scotland in 1999, whereby police officers were trained to perform roadside impairment tests; this study showed that forensic analysis confirmed the presence of a drug in 92% of the drivers who were suspected of taking a drug, who had failed the Field Impairment Tests (FIT), and who had provided a sample. As a consequence, FIT has been introduced across the United Kingdom with some police forces pursuing it more vigorously than others. This contrasts dramatically with the United States, where in 1979, the Drug Recognition Expert (DRE) Program was introduced. Police officers were trained to observe and document known indicators of drug use and impairment.

Instead of breath testing, a series of Standardized Field Sobriety Tests, including test of psychomotor and divided attention skills, is conducted. The following tests are administered when alcohol-induced impairment is suspected: Walk and Turn Test, One Leg Stand, and the Horizontal Gaze Nystagmus Test. If drug use is suspected, a Romberg Balance Test is also administered. Unlike chemical tests, where refusal to submit to testing may result in immediate license suspension, drivers in the United States are not legally required to take any Field Sobriety Tests; if the driver submits, however, the results can be introduced as additional evidence of impairment.

Various kinds of tests are used. They are designed to assess the individual's balance and coordination as well as the ability to follow simple instructions, i.e., to divide attention between multiple tasks. They are as follows:

- Horizontal Gaze Nystagmus: nystagmus may be caused by any number of conditions, but its presence could indicate drugs or alcohol.

- Walk and Turn: nine steps heel to toe are taken in one direction, and then the individual turns and repeats the process in the other direction. Eight impairment indicators are measured; if two of the eight are present, impairment would be indicated.
- One Leg Stand: the subject has to stand on alternate feet for 30 s while counting aloud. Failing two of the four recognized indicators indicates impairment.
- Romberg Balance Test: the subject stands with eyes closed and estimates a period of 30 s during which body sway is estimated. Some drugs alter the body's internal clock and make the test subject act faster or slower than they normally would. The test allows for a tolerance of ±10 s.

If impairment is identified, and alcohol is suspected, the driver undergoes breath testing and a similar procedure to the United Kingdom Section 5 RTA procedure is carried out. However, if drugs are suspected, the police officer calls for a DRE to carry out a more detailed examination.

The DRE uses a 12-step procedure:

1. Breath alcohol test: this is carried out by the arresting officer; if the reading is not consistent with the degree of impairment, the DRE is called in.
2. Interview with the arresting officer: the purpose is to ascertain baseline information including the circumstances of the arrest, whether an accident occurred, whether drugs were found, and if so, what they looked like.
3. Preliminary examination: the purpose of the preliminary examination is to determine whether there is sufficient reason to suspect a drug offense and, if possible, exclude any underlying medical problems. General observations and details of any current medical problems are ascertained, and the first pulse measurement is taken. If no signs of drug influence are found, the procedure is terminated; if any medical problems are found, a medical assessment is obtained, and if drugs are still suspected, a full assessment is carried out. If at any time during the assessment a serious medical condition is suspected, a medical opinion will be obtained.
4. Eye examination: the driver is assessed for horizontal gaze nystagmus, vertical gaze nystagmus, and convergence.
5. Divided attention tests: once at a police station, the Romberg Balance Test, Walk and Turn Test, One Leg Stand Test, and Finger to Nose Test are carried out. These are all examples of divided attention tests designed to assess balance and movement tests in addition to the subject's ability to remember instructions.
6. Vital signs examination: blood pressure, temperature, and a second recording of the pulse are performed
7. Darkroom examination: pupil size is measured in room light and then in near total darkness, using both indirect artificial light and direct light. The mouth and nose are also examined for evidence of drug use.
8. Muscle tone: limb tone is assessed as some drugs and some drug-related syndromes (particularly the potentially deadly Serotonin Syndrome) cause rigidity, whereas others, e.g., alcohol, cause flaccidity.

9. Injection sites examination: the purpose is to seek evidence of intravenous or injection drug abuse. A third pulse reading is also taken.
10. Interrogation: a structured interview about the use of drugs is carried out.
11. Opinion: based on all the previous assessments, the DRE forms an opinion as to drug impairment and also the type of drug causing the problem, the legal standard being a reasonable degree of certainty.
12. Toxicology testing: at the same time, samples are obtained for toxicologic examination; of either a blood or urine is collected for analysis of common drugs.

Initial studies suggesting very high sensitivity and specificity for DRE examination [99] have not been confirmed in controlled laboratory studies. The results of the few studies that have been performed suggest that the accuracy of DRE assessment in general may not be sufficiently good to provide evidence in court fairly [74, 75]. Several field studies have indicated that a DRE's opinions were confirmed by toxicologic analysis in 74–92% of cases when DREs concluded that suspects were impaired. However, published controlled trials, in which blood levels were measured before and during DRE examination, have shown that except in the case of alcohol, DRE assessment agreed with toxicology findings only 32–44% of the time.

There are other options for roadside screening tests. Both sweat and saliva have been used [100]. Devices are already available, and some have been approved by the U.S. Department of Transportation for the testing of commercial drivers. Even nonvolatile molecules appear in the breath, and the feasibility of even detecting amphetamine by breath testing has been demonstrated [101]. It is very likely that the scope of roadside breath testing will expand in the future. The mere detection of a drug does not prove impairment unless, of course, the jurisdiction has *per se* laws whereby the detection of drugs at some predetermined level is ruled, by law, to be proof of impairment. Roadside drug screening tests are acceptable to the public – a UK study [102] found that 98% of drivers were in favor of the principle of roadside drug screening and found the test methods of saliva or forehead perspiration generally acceptable. The UK Home Office Police Scientific Development Branch is currently researching the use of computer programmes for detecting impairment and Surface Enhanced Raman Spectroscopy (SERS) as a means of quantitative analysis of saliva for drugs.

Medical Examination Under Section 4, RTA

In the United Kingdom it is not necessary to prove impairment, as Section 7(3)(c) of the RTA states that "the suspected offence is one under Section 3A or 4 of this Act and the constable has been advised by a medical practitioner that the condition of the person required to provide the specimen *might* (author's emphasis) be due to some drug." It is for the court to decide whether the driver is unfit to drive on the evidence before it.

Whether the examination is carried out by a Forensic Physician in London, or an emergency room physician in San Francisco, the aim of the examination is to exclude any medical condition other than alcohol or drugs as the cause of the driver's behavior. The differential diagnosis is very wide and includes head injury, neurological problems (e.g., epilepsy, stroke, cerebral tumor, multiple sclerosis), metabolic problems (e.g., hypoglycemia), hepatic or renal failure, and mental illness. The procedure should include introductory details, full medical history, and clinical examination. In Scotland, police surgeons use form F97. The Faculty of Forensic and Legal Medicine has developed a pro forma for this purpose (see http://www.fflm.ac.uk for the most recent version). Similar forms are not available in the United States, but there is nothing to prevent any emergency department in the United States from drafting and providing a similar document. Even if no special form is provided, most of the relevant material will have been (or at least should be) recorded in the emergency department record.

Introductory Details

These should include the name, address, and date of birth of the driver and the name and number of the police officer as well as the place and date the examination took place. In addition, various times including time the doctor contacted, time of arrival at police station/hospital, and time the examination commenced and ended are recorded.

The doctor will need to know brief details of the circumstances leading to arrest and the results of any FIT that may have been carried out by the police officer. Informed consent should be obtained.

Full Medical History

Details of any current medical problems and details of recent events, particularly whether there was a road traffic accident that led to the event, should be recorded. Past medical history (with specific reference to diabetes, epilepsy, asthma, visual and hearing problems), past psychiatric history, and alcohol and drug consumption (prescribed, over the counter, and illicit) should be noted.

Clinical Examination

This should include general observations on demeanor and behavior, a note of any injuries, speech abnormalities, the condition of the mouth, the occurrence of hiccoughs, and any smell on the breath. The cardiovascular system should be examined and, as a minimum, the pulse, blood pressure, and temperature all should be recorded. Evidence of drug abuse should be sought, e.g., needle marks. Examination of the eyes should include state of the sclera, state of the pupils including size, reaction to light, convergence, and the presence of both horizontal or vertical nystagmus.

A series of divided attention tests should be performed including the Romberg Test, Finger Nose Test, One Leg Stand Test, and Walk and Turn Test. A survey of Police Surgeons' opinions within Strathclyde Police demonstrated concerns regarding the introduction of standardized field sobriety tests with the Walk and Turn Test and the One Leg Stand Test causing the highest levels of concern [103]. The mental state should be assessed and a sample of handwriting obtained. Fitness for detention is of paramount importance, and any person who is not fit to be detained because of illness or injury should be transferred to hospital and not subjected to a Section 4 assessment. If the person refuses to consent to an examination, it is prudent to make observations on his or her manner, possible unsteadiness, etc. and make written note of these.

At the end of the examination, the doctor should decide whether there is a condition present that might be due to some drug. In the case of very short-acting drugs, the observations of the police officer or other witnesses can be of crucial importance. In one well-reported case, an individual was found guilty of driving while unfit through drugs entirely on the basis of the officer's observations and the results and opinion of the toxicologist – the police surgeon was not called to give evidence [104]. Similarly, if the police officer reports that the person was swerving all over the road but the doctor later finds only minimal physical signs, this may be sufficient to indicate that a condition may be present due to some drug, e.g., cannabis, and that it is appropriate to proceed to the next part of the procedure. This has now been clarified in the UK by case law [105] which held that the medical practitioner was entitled to take into account all relevant information relating to the person's earlier condition. Except in situations where a felony has occurred (e.g., hit-and-run accidents, or automotive accidents resulting in grevious bodily harm), the opposite situation applies in the United States where physicians rarely if ever see individuals charged with impaired driving. Under U.S. law, if a suspected felony has occurred, the driver has no right to refuse testing and a physician may be called upon to draw blood for testing.

The doctor should inform the police officer whether there is a condition present that might be due to a drug and if so, the police officer will then continue with the blood/urine option as in Section 5 RTA, previously described. Consent will need to be obtained for a blood specimen. On this occasion, 10 mL of blood should be taken and divided equally into two septum-capped vials as the laboratory requires a greater volume of blood for analysis because of the large number of drugs potentially affecting driving performance and their limited concentration in body fluids; indeed, if the driver declines the offer of a specimen, both samples should be sent.

As a means of further validating FIT as an effective means of detecting drivers who are impaired due to drugs, the University of Glasgow carried out important research [106]. The drivers stopped under suspicion of impairment who were under the legal alcohol limit, but still considered impaired, were offered a FIT test. If they failed this test, they were considered as a suspect drug driver and examined by a forensic physician and a forensic sample obtained and analyzed if appropriate. Those who "passed" a FIT assessment were asked to voluntarily supply a sample of saliva, which was analyzed for drugs. In relation to the use of FIT, the assessment of impairment by a police officer using the test was supported by the clinical examination of the forensic physician in 77% of cases. Biological samples were only analyzed in 65% of this group, but significant drug use was confirmed in 94% of them. It was not possible to obtain biological specimens from drivers where the forensic physician did not corroborate the opinion of the arresting officer (23% of cases). Importantly, the study confirmed that oral fluid samples could be used to identify drugs in drivers, but of concern was the fact that, of those who were stopped and judged to be unimpaired by the police officer, 71% had drug-positive saliva samples.

In 2004, the Railways and Transport Safety Act (2003) was enacted which introduced in the UK a Code of Practice for Preliminary Impairment Tests, making it a legal requirement for motorists to undertake a roadside FIT test. The Act also provided for the Provision of a Preliminary Drug Test by way of sweat or saliva, though this has not yet been implemented as type approval of testing machines is awaited.

In 2010, the UK Government commissioned a report [38] by Sir Peter North QC to review drink drugs driving legislation. Whether his wide ranging proposals will be implemented remains to be seen.

In Victoria Australia [107], Forensic Physicians with relevant qualifications and experience act as experts for the court by reviewing all the evidence of impaired driving, the police Preliminary Impairment Test, the Forensic Physician's assessment, and toxicological results and provide an opinion. Very few expert opinions have been challenged in court. However, there were a number of inconsistencies in the physical examination with the drugs eventually found on toxicological examination; cases where the individual were barely conscious where a formal assessment should not even have been considered; and missed medical and psychiatric conditions.

References

1. Finucane AK (1999) Legal aspects of epilepsy. Neurol Clin 17:235–243
2. Austroads (2006) Assessing fitness to drive: for commercial and private vehicle drivers, Sydney
3. Fitten LJ (1997) The demented driver: the doctor's dilemma. Alzheimer Dis Assoc Disord 11(suppl 1):57–61
4. Driver and Vehicle Licensing Agency (2010) For medical practitioners: at a glance guide to the current medical standards of fitness to drive. Drivers medical unit. DVLA, Swansea
5. Osawa M, Nagasawa T, Yukawa N, Nakajima Y, Seto Y, Ohki T et al (1998) Sudden natural death in driving: case studies in the western area of Kanagawa. Nippon Hoigaku Zasshi 52:315–318
6. Cheng LH, Whittington RM (1998) Natural deaths while driving: would screening for risk be ethically justified? J Med Ethics 24:248–251
7. Belkic K, Emdad R, Theorell T (1998) Occupational profile and cardiac risk: possible mechanisms and implications for professional drivers. Int J Occup Med Environ Health 11:37–57
8. Conti JB, Woodard DA, Tucker KJ, Bryant B, King LC, Curtis AB (1997) Modification of patient driving behavior after implantation of a cardioverter defibrillator. Pacing Clin Electrophysiol 20(9 Pt 1):2200–2204

9. Bansch D, Brunn J, Castrucci M, Weber M, Gietzen F, Borggrefe M et al (1998) Driving and arrhythmias. J Am Coll Cardiol 31(3):608–615
10. Medical Research Council Antiepileptic Drug Withdrawal Study Group (1993) Prognostic index for recurrence of seizures after remission of epilepsy. BMJ 306:1374–1378
11. Krumholz A (1994) Driving and epilepsy: a historical perspective and review of current regulations. Epilepsia 35:668–674
12. MacLeod KM (1999) Diabetes and driving: towards equitable, evidence-based decision-making. Diab Med 16:282–290
13. Ehrlich EN (1991) Diabetes and the license to drive. Wis Med J 90:115–118
14. Distiller LA, Kramer BD (1996) Driving and diabetics on insulin therapy. S Afr Med J 86(8 suppl):1018–1020
15. Charman WN (1997) Vision and driving – a literature review and commentary. Ophthalmic Physiol Opt 17:371–391
16. General Medical Council (2009) Guidance for doctors. Confidentiality: supplementary guidance. GMC, London
17. Ellenhorn MJ et al (1997) Ellenhorn's medical toxicology: diagnosis and treatment of human poisoning. Williams & Wilkins, Baltimore
18. Jones A, Pounder D (1998) Measuring blood-alcohol concentration for clinical and forensic purposes. In: Karch S (ed) Drug abuse handbook. CRC Press, Boca Raton, pp 327–356
19. Noordzij PC, Roszbach R (1987) Alcohol, drugs, and traffic safety, in T86: Proceedings of the 10th International Conference on Alcohol, Drugs, and Traffic Safety, Amsterdam, September 9–12, 1986. Excerpta Medica, New York
20. Borkenstein RF, Dale A (1964) The role of the drinking driver in traffic accidents. Department of Police Administration. Indiana University, Bloomington
21. Allsop RE (1996) Alcohol and road accidents: a discussion of the Grand Rapids study. Road Research Laboratory. (RRL Report No 6), Harmondsworth.
22. Compton RP, Blomberg RD, Moskowitz H, Burns M, Peck RC, Fiorentino D (2002) Crash Risk of Alcohol Impaired Driving in T2002 Proceedings of the 16th International Conference on Alcohol, Drugs and Traffic Safety, Montreal
23. California Code of Regulations (1999) Title 13, Motor Vehicles, State of California
24. Pounder D, Jones G (1998) Measuring alcohol post-mortem. In: Karch S (ed) Drug abuse handbook. CRC Press, Boca Raton, pp 356–374
25. Aberg L (1993) Behaviours and opinions of Swedish drivers before and after the 0.02% legal BAC limit of 1990, in T9: proceedings of the 12th International Conference on Alcohol, Drugs, and Traffic Safety; Cologne, 1992. In: Utzelmann HD, Berghaus G (eds)
26. Department of Environment, Transport and the Regions (1998) Combating drunk-driving – next steps. A consultation document. DETR, UK
27. Dunbar JA, Penttila A, Pikkarainen J (1987) Drinking and driving: success of random breath testing in Finland. BMJ 295:101–103
28. Marsden A (1996) Accidental injury and traffic medicine. In: McLay WDS (ed) Clinical Forensic Medicine. Greenwich Medical Media, London, p 231
29. Coben JH, Larkin GL (1999) Effectiveness of ignition interlock devices in reducing drunk driving recidivism. Am J Prev Med 16(1 suppl):81–87
30. Sheldrake v Director of Public Prosecutions (2003) EWHC 273 (Admin)
31. Pugh v Knipe. R.T.R. 286 (1972)
32. Wallwork v. Giles. 114 S.J. 36 (1969)
33. Krause KR, Howells GA, Bair HA, Bendick PJ, Glover JL (1998) Prosecution and conviction of the injured intoxicated driver. J Trauma 45:1069–1073
34. McArthur DL, Kraus JF (1999) The specific deterrence of administrative per se laws in reducing drunk driving recidivism. Am J Prev Med 16(1 suppl):68–75
35. Faculty of Forensic and Legal Medicine/British Medical Association (2010) Taking blood specimens from incapacitated drivers. Guidance for doctors
36. Kaye S, Cardona E (1969) Errors of converting a urine alcohol value into a blood alcohol level. Am J Clin Pathol 52:577–584

37. Winek CL, Esposito FM (1981) Comparative study of ethanol levels in blood versus bone marrow, vitreous humor, bile and urine. Forensic Sci Int 17:27–36
38. North P (2010) Report of the review of drink drug driving law. Department for Transport. DfT Publications, London
39. Carter PG, McConnell AA (1990) Alcohol in drink driving swabs: does it make any difference? [letter]. Med Sci Law 30:90
40. Chief Constable of Avon and Somerset v. Singh. R.T.R. 107 (1988)
41. D.P.P. v Kinnersley. The Times, December 29 D.C (1992)
42. D.P.P. v Pearman. R.T.R. 407 (1992)
43. Young v D.P.P. R.T.R. 328 (1992)
44. Gomm PJ, Osselton MD, Broster CG, Johnson NM, Upton K (1991) Study into the ability of patients with impaired lung function to use breath alcohol testing devices. Med Sci Law 31:221–225
45. Gomm PJ, Broster CG, Johnson NM, Hammond K (1993) Study into the ability of healthy people of small stature to satisfy the sampling requirements of breath alcohol testing instruments. Med Sci Law 33:311–314
46. Odell M, McDonald C, Farrar J, Natsis JS, Pretto JF (1998) Breath testing in patients with respiratory disability. J Clin Forensic Med 5:45–48
47. Honeybourne D, Moore AJ, Butterfield AK, Azzan L (2000) A study to investigate the ability of subjects with chronic lung diseases to provide evidential breath samples using the Lion Intoxilyzer ® 6000 UK breath alcohol testing device. Respir Med 94:684–688
48. Logan BK, Gullberg RG (1998) Lack of effect of tongue piercing on an evidential breath alcohol test. J Forensic Sci 43:239–240
49. Kuldip Singh Gill v D.P.P. January 16 (1995)
50. Solesbury v Pugh. 1 W.L.R. 1114 (1969)
51. Bayliss v. Thames Valley Police Chief Constable (1978) Criminal Law Review. p 363
52. Beck v Watson. R.T.R. 91 (1980)
53. Robinson SP (1996) Road traffic offences. In: Robinson SP (ed) Principles of forensic medicine. Greenwich Medical Media, London. Distributed world-wide by Oxford University Press, pp 139–147
54. R v Bolton JJ. Ex p Scally 1 Q.B. 537 (1991)
55. R v Harding. R.T.R. 325 (1974)
56. Stark MM, Brener N (2000) Needle Phobia. J Clin Forensic Med 7:35–38
57. Rix K (1996) Blood or needle phobia as a defence under the Road Traffic Act of 1988. J Clin Forensic Med 3:173–177
58. Jones AW (1991) Top ten defence challenges among drinking drivers in Sweden. Med Sci Law 31:229–238
59. Jones A, Logan B (1998) DUI defenses. In: Karch S (ed) Drug abuse handbook. CRC Press, Boca Raton, pp 1006–1046
60. DDP v Mukandiwa (2005) EWHC 2977
61. Rowland v. Thorpe. 3 All E.R. 195 (1970)
62. Acevedo CG, Tamayo L, Contreras E (1986) Effects of morphine in the isolated mouse urinary bladder. Gen Pharmacol 17:449–452
63. Davis AR, Lipson AH (1986) Central nervous system tolerance to high blood alcohol levels. Med J Aust 144:9–12
64. Felby S, Olsen J (1969) Comparative studies of postmortem ethyl alcohol in vitreous humor, blood, and muscle. J Forensic Sci 14:93–101
65. Seppala T, Linnoila M, Mattila MJ (1979) Drugs, alcohol and driving. Drugs 17:389–408
66. Mattila MJ, Vanakoski J, Kalska H, Seppala T (1998) Effects of alcohol, zolpidem and some other sedatives and hypnotics on human performance and memory. Pharmacol Biochem Behav 59:917–923
67. Ramaekers JG (1998) Behavioural toxicity of medicinal drugs. Practical consequences, incidence, management and avoidance. Drug Saf 18:189–208
68. Rowe D (1999) Personal communication. DETR

69. Osselton MD, Owen P, Fysh R (1996) Drugs and driving, Forensic Science Service Report No. TN816. Forensic Science Service, London, p 3
70. Tunbridge RJ, Keigan M, James FJ (2001) The incidence of drugs in road accident fatalities. TRL report 495. Crowthorne, England. TRL Ltd
71. Myant K, Hope S, McIntosh J, O'Brien Y, McKeganey N, Stradling S (2006) Illicit drugs and driving. Transport Research Series. Scottish Executive Social Research, Edinburgh
72. Berghaus G, Scheer N, Schmidt P (1995) Effects of cannabis on psychomotor skills and driving performance – a meta-analysis of experimental studies, in T95 Proceedings of the 13th International Conference on Alcohol, Drugs, and Traffic Safety, Adelaide, 1994
73. Chait L, Pierri J (1992) Effects of smoked marijuana on human performance: a critical review. In: Murphy L, Bartke A (eds) Marijuana/Cannabinoids: neurobiology and neurophysiology. CRC Press, Boca Raton
74. Heishman S, Karch S (2000) Drugs and driving. In: Siegel J, Saukko P, Knupfer G (eds) Encyclopaedia of forensic sciences. Academic, London
75. Heishman SJ, Singleton EG, Crouch DJ (1998) Laboratory validation study of drug evaluation and classification program: alprazolam, d-amphetamine, codeine, and marijuana. J Anal Toxicol 22:503–514
76. Sexton BF, Tunbridge RJ, Brook-Carter N, Jackson PG, Wright K, Stark MM, Engelhart K (2000) The influence of cannabis on driving. TRL Report 477. TRL Limited
77. Lenné MG, Dietze PM, Triggs TJ, Walmsley S, Murphy B, Redman JR (2010) The effects of cannabis and alcohol on simulated arterial driving. Accid Anal Prev 42(3):859–866
78. Karschner EL, Schwilke EW, Lowe RH, Darwin WD, Herning RI, Cadet JL, Huestis MA (2009) Implications of plasma Delta9-tetrahydrocannabinol, 11-hydroxy-THC, and 11-nor-9-carboxy-THC concentrations in chronic cannabis smokers. Addiction 104(12):2041–2048
79. Chesher G, Lemon J, Gomel M, Murphy G (1989) The effects of methadone, as used in methadone maintenance program, on driving related skills. National Drug and Research Centre, Sydney
80. Friedel B, Berghaus S (1995) Methadone and driving. In: T95 Proceedings of the 13th International Conference on Alcohol, Drugs and Traffic Safety, Adelaide, Australia
81. Bernard JP, Morland J, Khiabani HZ (2009) Methadone and impairment in apprehended drivers. Addiction 1004:457–464
82. Koelega HS (1993) Stimulant drugs and vigilance performance: a review. Psychopharmacology 111:1–16
83. Farre M, Llorente M, Ugena B, Lamas X, Cami J (1991) Interaction of cocaine with ethanol. NIDA Res Monogr 105:570–571
84. Logan BK (1996) Methamphetamine and driving impairment. J Forensic Sci 41:457–464
85. De Waard D, Brookhuis KA, Pernot LMC (2001) A driving simulator study on the effects of MDMA (Ecstasy) on driving performance and traffic safety in T2000 Proceedings of the International Conference on Alcohol, Drugs, and Traffic Safety, Stockholm, 2000
86. Burns M (1993) Cocaine effects on performance. In: Utzelmann H, Berghaus G, Ktoj G (eds) Alcohol, drugs and traffic safety, T92, Band 2. TUV Rheinland, Cologne
87. Soderstrom CA, Dischinger PC, Kufera JA, Ho SM, Shepard A (2005) Crash culpability relative to age and sex for injured drivers using alcohol, marijuana or cocaine. Annu Proc Assoc Adv Automot Med 49:327–341
88. Musshoff F, Madea B (2010) Cocaine and benzoylecgonine concentrations in fluorinated plasma samples of drivers under suspicion of driving under influence. Forensic Sci Int 200(1–3):67–72
89. O'Hanlon JF, Vermeeren A, Uiterwijk MM, van Veggel LM, Swijgman HF (1995) Anxiolytics' effects on the actual driving performance of patients and healthy volunteers in a standardized test. An integration of three studies. Neuropsychobiology 31:81–88
90. Barbone F, McMahon AD, Davey PG, Morris AD, Reid IC, McDevitt DG et al (1998) Association of road-traffic accidents with benzodiazepine use [see comments]. Lancet 352:1331–1336

91. Bramness JG, Skurtveit S, Mørland J (2003) Clinical impairment of benzodiazepines – relation between benzodiazepine concentrations and impairment in apprehended drivers. Pompidou Group, Strasbourg
92. Chesher GB, Dauncey H, Crawford J, Horn K (1996) The interaction between alcohol and Marijuana. Report to the Australian Federal Office of Road Safety. Department of Pharmacology. University of Sydney, Sydney
93. Sexton BF, Tunbridge RJ, Brook-Carter N, Jackson PG, Wright K, Stark MM, Engelhart K (2002) The influence of cannabis and alcohol on driving. TRL Report 543. TRL Limited
94. Hindmarch I (1993) Psychiatry in Practice. Winter: 23–25.
95. O'Hanlon JF, Robbe HW, Vermeeren A, van Leeuwen C, Danjou PE (1998) Venlafaxine's effects on healthy volunteers' driving, psychomotor, and vigilance performance during 15-day fixed and incremental dosing regimens. J Clin Psychopharmacol 18:212–221
96. Bhatti JZ, Hindmarch I (1989) The effects of terfenadine with and without alcohol on an aspect of car driving performance. Clin Exp Allergy 19:609–611
97. Choi H, Baeck S, Kim E, Lee S, Jang M, Lee J (2009) Analysis of cannabis in oral fluid specimens by GC-MS with automatic SPE. Sci Justice 49(4):242–246
98. Tunbridge RJ, Keigan M, James FJ (2001) Recognising drug use and drug related impairment in drivers at the roadside. TRL report 464. Crowthorne, England. TRL Ltd
99. Burns M, Adler E (1995) Study of a drug recognition expert (DRE) program, in T95: Proceedings of the 13th International Conference on Alcohol, Drugs, Traffic Safety, Adelaide, 1994
100. Kidwell DA, Holland JC, Athanaselis S (1998) Testing for drugs of abuse in saliva and sweat. J Chromatogr B Biomed Sci Appl 713:111–135
101. Beck O, Leine K, Palmskog G, Franck J (2010) Amphetamines detected in exhaled breath from drug addicts: a new possible method for drugs-of-abuse testing. J Anal Toxicol 34(5):233–237
102. Tunbridge RJ, Rowe DJ (1999) Roadside identification of drug impaired drivers in Great Britain. 10th International Conference on Road safety in Europe, Malmo
103. O'Keefe M (2001) Drugs driving – standardized field sobriety tests: a survey of police surgeons in Strathclyde. J Clin Forensic Med 8:57–65
104. Leetham v. D.P.P. Q.B. 488 (1998)
105. Angel v Chief Constable of South Yorkshire (2010) EWHC 883 (Admin)
106. Oliver JS, Seymour J, Wylie FM, Torrance H, Anderson RA (2006) Monitoring the effectiveness of UK Field Impairment Tests. Road Safety Research Report No. 63. Department for Transport, London
107. Odell MS (2002) Expert Opinion in DUID Cases Based on Interpretation and Observation and Toxicology in T2002 Proceedings of the 16th International Conference on Alcohol, Drugs and Traffic Safety, Montreal

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