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SURGERY

A Competency-Based Companion

BARRY D. MANN

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SURGERY:
A Competency-Based Companion

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Educator's Foreword

There is no steeper learning curve in medicine than residency. The dramatic difference between interns and chief residents can be described as a journey—a journey to authenticity—a journey in which young physicians discover both clinical wisdom and themselves, a journey in which they become authentic surgeons. The work before the journey begins in medical school, on surgical clerkships, when students discover the cognitive and interpersonal skills needed to approach common surgical problems. Students share with residents two primal fears: they don't want to hurt anybody (a situation made especially complex in surgery, where in order to help a patient it may be necessary to hurt him) and they don't want to appear stupid. In confronting these fears both students and residents begin to develop the habits of a lifetime. There are four reasons why this book will help.

First, it deconstructs the needed competence into six competencies that are both manageable and enduring. The same six competencies will be used throughout the life of the surgeon: in residency; for initial board certification; and for maintenance of certification once a practicing surgeon. Second, the surgical problems presented are both common and important. They illustrate the approach of the complete surgeon and provide examples to guide learners on their journey. Third, the book is exceptionally well written and well organized. Readers can learn about the surgical problem by going through the cases or they can learn about the competency, for example, by going through the 53 professionalism pieces. Fourth, the book successfully integrates the general rules of surgery with particular concrete contexts. The journey to competence begins by learning the rules and proceeds by applying those rules in different and ever more complex contexts. This book bridges the two steps; it provides clarity as readers confront uncertainty; it tells them what to notice and how to make sense out of what they notice, and it provides an orderly basis for action. An ancient mantra, "To teach is to create a space in which obedience to truth is practiced" captures the power of the relationships in teaching. This book will facilitate conversations designed to discern the truth and obey it. Enjoy it.

David C. Leach MD
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Surgical Educator's Foreword

The Accreditation Council for Graduate Medical Education (ACGME) has defined six core competencies that must be addressed by all residency programs. These are medical knowledge, patient care, interpersonal and communication skills, professionalism, practice-based learning and improvement, and systems-based practice. Residency programs have made major changes in their educational activities to address the core competencies, and a variety of efforts to offer competency-based education are currently underway. Medical students need to be prepared adequately for residency education, which requires special emphasis on these competencies. In 2005, the American College of Surgeons (ACS) published a resource, "Successfully Navigating the First-Year-of Surgical Residency: Essentials for Medical Students and PGY-1 Residents." This publication lists the essential areas of knowledge and skills for all entering PGY-1 surgical residents within the framework of the six core competencies and serves as a useful guide for medical students, surgical residents, and the faculty. There has been a vital need to develop a comprehensive text for medical students to address surgical content within the context of the competencies.

Surgery: A Competency-Based Companion addresses this important need. It includes several unique features that make the book both relevant and timely. The case-based format encourages active learning and helps by applying theoretical constructs to surgical practice. All six core competencies are covered within the context of each case, and the color coding used to highlight each competency is helpful to learners. The focus on evidence-based surgery within the framework of practice-based learning and improvement underscores the scientific basis of the clinical content. The vertical reads of the core competencies available online present a valuable summary that should be useful in reinforcing key concepts. The special features of this text, such as the Teaching Visuals, Professor's Pearls, and summary information on "Speaking Intelligently," add additional educational value. The information on costs of various tests and imaging studies is important in educating students about appropriate resource management.

Thus this book displays a new approach to presenting important surgical content within the framework of the six core competencies and should serve as an important resource for both medical students and faculty. It should be helpful to all medical students, not just those who are interested in pursuing careers in surgery. Dr. Barry Mann and the authors of this book deserve to be commended for producing this valuable text, which should be useful in supporting the new directions in surgical and medical education.

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Preface

At the turn of this millennium, the Accreditation Council on Graduate Medical Education (ACGME) introduced the six competencies into the language of medical instruction. Medical educators must now verify that trainees are skilled in these competencies: Patient Care, Medical Knowledge, Practice-Based Learning and Improvement, Interpersonal and Communication Skills, Professionalism, and Systems-Based Practice.

Surgery: A Competency-Based Companion is the first attempt to incorporate and integrate this six-competency framework into a surgical textbook. The intent is that students rotating through a surgical service will realize that, just as it is important to acquire medical knowledge, it is similarly important to hone interpersonal and communication skills, be cognizant of issues of professionalism, learn how the system works, and be vigilant about the need for self-assessment. Surely these are the *processes* by which we improve our doctoring skills. By integrating these issues into the case-based text, it is my hope that those who use *Surgery: A Competency-Based Companion* will continually be reminded to develop and refine not only the content of what they know but the process of how they interact with patients and colleagues.

At the outset of medical school, medical knowledge is catalogued by organ systems and diseases. As the student's experience with patients becomes more central, the student must recatalogue medical knowledge according to how patients commonly present for care. Accordingly, this book offers 53 patient presentations likely to be encountered by students and residents on a surgical service.

Each surgeon contributing a case-based chapter to this book submitted his or her own ideas on how interpersonal skills, professionalism, and the systems-based competencies pertain to the case. In order to avoid redundancy, some of these contributions were eliminated, some were altered, and, after consultation with special competency editors, different selections were inserted. Hence each case-based chapter became a collaborative work of multiple contributors. There were always numerous choices regarding which ideas to include and where to place them. With great appreciation for the competency editors who strove to make the assemblage of contributions most meaningful to students, I, the editor, take full responsibility for the choices made in concept selection and placement.

It is our intent that the collection of 53 paragraphs selected for the various competencies will constitute “mini-curricula” for each competency as they apply to the arena of surgery. In order to facilitate use of these “mini-curricula” by clerkship directors and program directors in initiating discussions with learners, these selections have been organized by competency and are downloadable as separate pdf files from the book’s Web site on www.studentconsult.com.

In the practice of medicine, the need for continual and accurate self-assessment is paramount. In the context of the Practice-Based Learning and Improvement competency, 22 chapter-related Morbidity and Mortality Self-Assessment Forms have been interspersed throughout this book to model appropriate analysis of complications. It is my hope that students and residents will be motivated by these examples to analyze postoperative complications they encounter with their own patients. For this purpose, a blank Morbidity and Mortality Self-Assessment Form (which can be photocopied or downloaded as a Word document from www.studentconsult.com) has been provided on page 34.

A general Competency Self-Assessment Form (which can also be photocopied or downloaded from www.studentconsult.com) appears on page 35. The intent is to provide a structure by which students and residents can actively review and critique their own patient care. Building a portfolio of such documents may be encouraged at the discretion of the clerkship director or program director. At the end of each section of this book, the reader is reminded of the importance of such self-assessment.

Focusing on process, the Critical Care Section (Section XII) begins by illustrating a simplified ICU flow sheet in order to familiarize the student with the process of collecting and synthesizing ICU patient data. The intent is to minimize the often overwhelming and intimidating nature of the task. The overview of critical care can be read (though not mastered) in 2 to 2.5 hours, and the section concludes by introducing the student to the process of case analysis, thereby reviewing and integrating the material presented in the text.

In the Operations Section of the book (Section XIV) the reader will find 37 of the most common general surgery procedures, each reduced to a one-page, competency-based format. The intent is to demonstrate the process of preparation for the Operating Room by presenting operative indications, relevant knowledge points to acquire, basic surgical steps, and an awareness that potential complications must be anticipated if they are to be avoided.

The book contains five “Teaching Visuals” in which students are encouraged to connect dots to draw pictures for themselves (medical knowledge) and/or for their patients (interpersonal skills). Microscopic breast pathology, relations of the pancreatic head, the Roux-en-Y limb, coronary revascularization, and peripheral vascular anatomy are just a few of the many surgical concepts that demand full visual comprehension. One cannot intelligently discuss obstructive jaundice, for example, without knowing that the pancreatic duct and common bile duct run through the pancreatic parenchyma to join at the Ampulla of Vater. Nor can one intelligently describe the function of a Roux-en-Y limb without being able to visualize how it is constructed. The idea of "connecting the dots" is used to activate the study process and reinforce these important visual concepts. Clearly, hundreds more of these visuals could be created. The hope is that students will adopt the *process* of creating and using their own visuals for clarification and reinforcement of their own knowledge and for enhancement of their doctor-patient relationships.

I hope that *Surgery: A Competency-Based Companion* will serve as a resource for students and their instructors to meaningfully integrate competency education into their daily training routines.

Barry D. Mann MD

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Acknowledgments

Surgery: A Competency-Based Companion would not have become a reality were it not for the vision and trust of Jim Merritt, Elsevier Senior Acquisitions Editor. Jim has been a key partner in the development of this book. He has trusted and encouraged and he has welcomed creativity. Christine Abshire quickly developed a keen understanding of the book's mission and has been a delightful collaborator as Developmental Editor. Lou Forgione actualized the elements of the vision with a terrific design. As Production Editor, Peggy Gordon has helped immensely with the final shaping of the book and the refinements of the text.

This project could not have been assembled without the collaboration of many members of the Association for Surgical Education (ASE) and the Association of Program Directors in Surgery (APDS) who served as key contributors, section editors, and competency editors. I thank them for their untiring support. Most of them not only contributed chapters and edited sections but also spent hours talking about the project, advising on how to make it meaningful and student-friendly and a potentially valuable resource for clerkship directors and program directors.

Among my many treasured colleagues who contributed to this book is Dr. Philip J. Wolfson, who was serving as ASE President at the time of his tragic and untimely passing just prior to publication of this volume. An esteemed teacher and surgical educator at Jefferson Medical College in Philadelphia, Dr. Wolfson was a champion of student empowerment and a role model of compassion and humility for all. I call attention to his "Professor's Pearls" for Pediatric Surgery, which is published posthumously in Section X.

I am deeply indebted to my surgical residents, my surgical colleagues, and the faculty of the Lankenau Hospital of the Main Line Health System of Wynnewood, Pennsylvania—just outside Philadelphia. Not only have they contributed to this manuscript, but they have served as ever-present sounding boards and advisors.

I would be remiss not to thank herein those many inspiring teachers of surgery whose instruction, encouragement, and role-modeling helped shape my own career in surgery. The list is long, so I will single out only two instructors who will represent all those from whom I have learned. Donald L. Morton, MD, currently Surgeon-in-Chief of the John Wayne Cancer Clinic, was a mentor and guide in both residency and surgical oncology fellowship. Don taught tenacity in the quest for medical knowledge and the importance of translational research for patient care. I am proud to have been one of his fellows. Donald E. Wagner, MD, of Santa Monica, California, my first partner in the practice of surgical oncology, was a role model of exemplary behavior in all competencies long before competency lingo penetrated medical education.

Lastly, but most importantly, I thank my family, to whom this book is dedicated. Committing oneself to a career in surgery is committing oneself to inevitable periodic distraction. When a patient has a rocky postoperative course, it is difficult for a surgeon not to put that patient's welfare paramount in his or her brain—no matter how hard one tries to compartmentalize life. I dedicate this book to my wife, Tilda, and to my children, Sara, Jonah, and Aviva, who have endured such distractions for many years, and who have, nonetheless, allowed me to add the assembling of this book to the list of my distractions. I thank them for their love and tolerance, for their continuous humor, and for the incessant teasing that keeps me humble.

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Chapter 1
How to Study This Book

Barry D. Mann MD

No matter the duration of the surgery clerkship, it is often difficult for students to make a reading and study plan during a surgical rotation. Under normal circumstances, students who are engaged in daily patient care and operating room activities do not have time to master an entire surgical reference text. Students are faced with the quandary, "Do I read a book to get an overview of general surgery, or do I focus on reading about my patients?" Ideally, one should do both. Below are comments about the purpose of this book and a few suggestions for prioritizing reading and study of concepts presented in this book.

This book is not an exhaustive compendium of all surgical knowledge. The purposes of this book are to (1) orient you to the cognitive processes associated with establishing a differential diagnosis and surgical decision making; (2) introduce you to interpersonal and system issues and solutions that impact on patient care; and (3) provide you with opportunities to conduct self-assessment.

STRUCTURE OF THE BOOK

This book includes 53 case-based chapters divided into 11 sections:

Abdominal Pain
Surgical Oncology
Vascular Surgery
Gastrointestinal Bleeding
Postoperative Care
Trauma
Bariatric Surgery
Cardiothoracic Surgery
Pediatric Surgery
Transplantation
Critical Care

ORGANIZING STRUCTURE

At the turn of this millennium, the Accreditation Council on Graduate Medical Education (ACGME) introduced the six competencies into the language of medical instruction. Medical educators must now verify that trainees are competent in Patient Care, Medical Knowledge, Practice-Based Learning and Improvement, Interpersonal and Communication Skills, Professionalism, and Systems-Based Practice.[1] Each of these competencies is explained and expanded in the next several introductory sections. In each case-based chapter, the six ACGME Competencies are color-coded for easy identification:

Patient Care
Medical Knowledge
Practice-Based Learning and Improvement
Interpersonal and Communication Skills
Professionalism
Systems-Based Practice

Competency definitions are provided in Appendix 1.

CHAPTER ELEMENTS

Each chapter begins with a CASE, followed by a Differential Diagnosis.

A paragraph entitled **Speaking Intelligently** sums up the "big picture" in language that you might use with a colleague. Next **Clinical Thinking, History, Physical Examination, Tests for Consideration,** and **Imaging Considerations** are considered the elements of **Patient Care** and comprise the most important aspects of the evaluation process.

The **Clinical Entities** boxes outline the entities considered in the differential diagnoses. The diagnoses listed for each case emphasize the ***most common diagnoses*** and are therefore typically fewer in number. Low-frequency diagnoses are described in the **Zebra Zone.** ("When you hear hoofbeats, think horses, not zebras."[2])

Each case includes issues and solutions about **Practice-Based Learning and Improvement, Interpersonal and Communication Skills, Professionalism,** and the **Systems-Based Practice** competencies.

SUGGESTIONS FOR READING

Begin by making a reading schedule based on your rotation assignment (e.g., if you start on the "Vascular Service," read the Vascular section first). If your rotation provides you no obvious cue for where to begin, read the Abdominal Pain section first. No matter what aspect of medicine will be your specialty, the surgical clerkship is the time to master the workup of abdominal pain.

Knowledge of the common differential diagnoses will orient you to educational conversation on rounds, because the underlying issue in patient-related discussions is the differentiation of one diagnostic possibility from another. If you do not know the differential diagnosis of upper gastrointestinal bleeding, it is difficult to participate in a discussion about its evaluation or treatment.

If you do not have time to read a complete chapter or section, read the *Differential Diagnosis* and the corresponding Clinical Entities boxes. Then use **Clinical Thinking, History, Physical Examination, Tests for Consideration,** and **Imaging Considerations** to understand the basic differentiation of one clinical entity from another. Note that many Clinical Entities and Zebra Zone entries are referenced to a chapter in Sabiston, *Textbook of Surgery,* 18th edition, or a chapter in Becker and Stucci, *Essentials of Surgery*. Look for either "**Sabiston**" or "**Becker**" and the chapter number. Information from both texts can be accessed through the Elsevier Student Consult Web site (www.studentconsult.com).

If your surgical service has numerous patients in the intensive care unit (ICU) and you are expected to follow them, orient yourself to the concept of the *ICU flow sheet* in the beginning of the Critical Care Section. The ICU flow sheet models novice and expert reporting and demonstrates expectations. The Critical Care chapters serve as an overview of common issues of ICU care. Reading these chapters takes approximately 2 hours and will introduce you to the issues of ICU Care. Critical Care exercises appear at the end of the Critical Care section. Read each case, then list the important critical care issues and prioritize them. Then turn the page and read how the expert analyzed the case.

TEACHING AND LEARNING ACTIVITIES

Teaching a peer is often a great way to reinforce your own knowledge, and diagramming for a patient can add substantially to the physician-patient relationship. Five Teaching Activities, such as drawing and or diagramming various entities, have been included throughout the book.

OPERATIONS

The *Operations* section consists of brief summaries to guide your preparation for participation in an operation.

THE COMPETENCIES AND VERTICAL READS

The surgeons who contributed to this book incorporated aspects of **Patient Care, Medical Knowledge, Practice-Based Learning and**

Improvement, Interpersonal and Communication Skills, Professionalism, and Systems-Based Competencies in the context of their cases. This book is organized to allow for a "vertical read," whereby readers may focus their study on each specific competency. Vertical reads of the Interpersonal and Communication Skills, Professionalism, and Systems-Based Competencies are available online.

A NOTE ABOUT PRACTICE-BASED LEARNING AND IMPROVEMENT

For the purposes of this book, the Practice-Based Learning and Improvement competency has been defined as having two specific components: evidence-based medicine and Morbidity and Mortality conference.

1. **Evidence-based information** has been abstracted and provided to demonstrate how problems can be solved by examining best evidence.
2. Because the **Morbidity and Mortality (M & M) conference** is the core of individual and collective self-assessment in surgery, a blank M & M form is provided at the end of this section (page 34) for student/resident use. Note that 22 completed M & M forms appear as examples within chapters of the book.

Performing routine and accurate self-assessment is an important part of effective practice. A *Competency Self-Assessment Form* also appears at the end of this section and is available on the Web. This form was designed to provide you with an opportunity to assess your performance regarding patients you have helped care for.

We hope that the features and organization of this volume will facilitate a productive and enjoyable learning process.

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Chapter 2
Medical Knowledge: The Foundation of Patient Care

Sandra Fine MBA *and Thomas G. McCarter* MD

The six ACGME competencies, which serve as the organizing principle of this book, all inter-relate; each category focuses directly on the same ultimate goal: good patient care. As should already be clear to any medical student with even a modicum of clinical experience, the cornerstone of quality patient care is the acquisition of medical knowledge.

Acquiring medical knowledge is an odyssey that will propel you in many directions. Each step of the journey challenges you to assimilate new information, learn new skills, and master new techniques. Understand that this odyssey has two unique characteristics: it is ever-changing and never-ending.

Never before have learners been challenged by such a vast flood of information. In the early 1990s, medical knowledge was thought to double in size approximately every 10 years. For the future, it is likely to double every 2 to 5 years. Every physician will need to design a method to manage the traffic of the information highway or opt for professional obsolescence. It is imperative, therefore, for you the student to understand how *you* learn best and to develop proper habits that will serve you during clerkship and residency, and, as a lifelong learner, during your years of medical practice.

As this textbook will demonstrate, clinical constructs change and accepted paradigms evolve, the field of laparoscopy providing an excellent example. Minimally invasive surgery was hardly a concept when many of this book's contributors were in surgical residency. Such evolution suggests that the ability to ask the good question may be more relevant to the mastery of medical knowledge than knowing the right answer. Good questions rarely change; "right answers" change frequently. Enjoy the never-ending and ever-changing journey on which you embark. Use this text to acquire medical knowledge, to polish your thought processes, and to gain further insight into patient care.

Chapter 3
Practice-Based Learning and Improvement

Mary Ann Hopkins MPhil, MD

Surely the practice of medicine is currently based on sound scientific evidence! Though this statement may seem like a “no-brainer,” the reality is somewhat different. The more experienced physicians become, the more likely they are to rely mostly on their past experience, being too busy to check for the most recent information. Medical students and residents have set curricula with defined educational goals and objectives, and they are taught in a relatively structured way. Practicing physicians, on the other hand, are responsible for keeping themselves up to date in a process called *Continuing Medical Education (CME)*.

The process of ongoing self-directed learning is called Practice-Based Learning and Improvement and is an area that was identified as one of six core competencies by the Accreditation Council on Graduate Medical Education (ACGME). Practice-based learning and improvement is a modality by which physicians reflect on their individual performances with the goal of improving their own practice through self assessment. It includes appraising and reviewing scientific evidence using *Evidence-Based Medicine (EBM)* and critically appraising the outcomes of their patients, often formally done at hospital-based Morbidity and Mortality (M & M) conferences and by quality assurance committees. For the educational purposes of this book, we have categorized Practice-Based Learning and Improvement into two elements: EBM and M & M Conference.

COMPONENT 1: EVIDENCE-BASED MEDICINE

There are two important principles on which EBM is based. The first principle is that physicians must stay current on treatment protocols that will address the specific needs of their patients. Learning in medicine doesn’t stop outside the classroom and doesn’t end after training. Much of what physicians learn in medical school will be outdated or disproved within 10 years; hence, for the sake of their patients’ well-being, physicians must acquire the ability to evaluate current medical knowledge and treatment and incorporate it into practice.

The second important principle of EBM is that one must be able to critically appraise and validly assess reported evidence. This process requires basic knowledge of study design and statistics to judge the internal and external validity of a study. There are many different systems to define levels of evidence and grade of recommendation.[1–4] These systems are similar, although no single system is used across all disciplines. The *level of evidence* (usually scaled from I to V) is used to describe the quality of evidence from a particular study. The *grade of recommendation* (usually scaled from A to D) is based on the quality and quantity of that evidence. The Cochrane Collaboration publishes a helpful glossary of related terminology.[5]

Critical analysis of lay and academic literature is even more important in the age of the Internet as patients come to doctors' offices more informed by resources that may be incomplete or inaccurate. The Internet has become an invaluable source of information offering easy access at the point of care. However, ensuring the quality of the content can be extremely difficult. Traditional medical journals offer some reassurances that the authors' materials have been peer reviewed and that the authors have no conflict of interest, financial or otherwise. Identifying the authorship of material on the Web is often difficult, and ensuring intellectual integrity and quality may be impossible. Medical societies are becoming valuable tools to help ensure the intellectual integrity and validity of materials by offering a portal to relevant information. Several sites, such as those from the American College of Surgeons (ACS; www.facs.org) or the American Association of Medical Colleges (AAMC; www.aamc.org), offer access to peer-reviewed educational material.

In addition to online medical journals and the sites of various medical societies, an important tool in researching new techniques and treatments is the use of *review articles* and *consensus statements*. One caveat about review articles is that they must be read carefully to determine whether a thorough literature search has been done and to ensure that the review results are not impacted by author bias. Consensus statements are usually promulgated by national organizations and offer concise and complete reviews of clinical issues. The clinical treatment options outlined in consensus statements emphasize patient care and outcomes. For example, the American Society of Colon and Rectal Surgeons (ASCRS) published an article, "Practice Parameters for Sigmoid Diverticulitis," published in *Diseases of the Colon and Rectum*.[6] The Standards Committee of the ASCRS assembled a group of experts who reviewed the best evidence available and developed a set of clinical practice guidelines. Collecting and archiving such guidelines for accessible review is a practice that can be helpful throughout your career.

There are several important tools to use when searching for information in surgery. *The Surgical Index (TSI)*, located on the ACS's Web site under "periodicals,"[7] is a monthly review of the current surgical literature distilled into abstract form, sometimes with editorial commentary. The *Cochrane Library* (www.cochrane.org), which is not specific to surgery, is a collection of evidence-based medicine databases. These quarterly reviews rigorously examine the effectiveness and appropriateness of interventions and treatments and include a "plain language summary."

COMPONENT 2: MORBIDITY AND MORTALITY CONFERENCE: A FRAMEWORK FOR SELF-ASSESSMENT AND PATIENT SAFETY

Susan Kaiser MD, PhD and Leo A. Gordon MD

Complications occur. They happen in the healthiest patients, with the best surgeons, under the strictest conditions, in the most modern hospitals and clinics. Some complications are difficult to avoid; they may be due to the inexorable progression of disease or to preexisting comorbidities. It is our goal always to reduce the likelihood of complications to an absolute minimum.

Doctors are obliged to keep the number of complications to a minimum, but how is this to be accomplished? The medical profession prescribes routines and mechanisms to review unfavorable events and outcomes objectively, so that we do not unnecessarily repeat bad-outcome behaviors and situations.

The ACGME defines Practice-Based Learning and Improvement as "investigating and evaluating one's own patient care practices, evaluating and assimilating scientific evidence, and improving one's own patient care practices."[8]

In surgery, the M & M Conference is designed for this very purpose. The purpose of the conference is to identify, based on best evidence, points at which different choices might have improved outcomes, or at which interventions might have been made to lessen the likelihood of error. Complications are classified as follows:

- Associated condition or comorbidity
- Progression of disease
- Error in diagnosis
- Error in technique
- Complications in treatment
- Error in judgment
- Delay in diagnosis

- Delay in treatment
- Missed injury
- Adverse reaction to medication
- Equipment malfunction
- Wrong procedure
- Wrong patient
- Wrong site

Any given complication may fall into more than one category, and complications need not be the result of errors or delays. Adverse outcomes may be classified as follows:

- Preventable
- Possibly preventable
- Probably preventable
- Unpreventable

Even when an error does not result in a complication or adverse outcome, it is still analyzed in the same manner.

Our goal is to reduce complications by acknowledging our responsibility for them and by learning from them, avoiding a punitive or judgmental approach.

Sample M & M report forms, completed by the contributing authors about case-relevant surgical complications, appear throughout the Practice-Based Learning and Improvement boxes of this book. These forms are intended to demonstrate the reflection and improvement process. To this end, a blank form is available at the end of this section for students to photocopy and utilize with their residents prior to each M & M conference for reporting complications. This weekly self-assessment will allow students to participate in dialogue with residents and attendings and become active participants in this important patient safety process.

M & M self-assessment forms are found in the following cases:

Complication Category	Cases
Associated condition or comorbidity	6, 8, 30
Error in diagnosis	26
Error in technique	2, 13, 15, 22, 37, 50, 52
Error in treatment	26
Error in judgment	5, 16, 38, 45
Delay in diagnosis	7
Delay in treatment	7
Wrong procedure	49
Wrong patient	25
Missed injury	33

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Chapter 4
Interpersonal and Communication Skills

Jane Ruddell Esq, Stephanie R. Landmesser RN, CNOR, MSN, Daria Arcaro BA, Nicholas P. Lang MD, and Pamela A. Rowland PhD

Communication is an integral component of physician skills and is a competency in which physicians must excel. Indeed, the interaction between patient and doctor is itself an important part of the healing process. Without properly developed interpersonal skills, medical knowledge cannot be applied to patient care, nor can one make the system work effectively for one's patient.

The Accreditation Council on Graduate Medical Education has defined the competency of interpersonal and communication skills as follows: "Residents must be able to demonstrate interpersonal and communication skills that result in effective information exchange and teaming with patients, their patients' families, and professional associates."[1]

In 2005 the American College of Surgeons (ACS) published a booklet entitled *Successfully Navigating the First Year of Surgical Residency: Essentials for Medical Students and PGY-1 Residents*. The booklet outlines communication behaviors and skills to be acquired by students and residents in surgery, including:

- Listen actively with cultural, ethnic, gender, racial, and religious sensitivity.
- Communicate effectively with patients' families and professional associates.
- Begin patient encounters, educate and advise patients, and end encounters, conveying sensitivity, compassion, and concern.
- Discuss medical errors and professional mistakes honestly and openly in order to promote learning.
- Convey key information accurately to the transition team assuming care.
- Appreciate and discuss sensitive issues with patients, including:
  - Death and dying,
  - Health maintenance and disease prevention,
  - Substance abuse
- Give accurate, clear, and concise oral presentations.[2]

Effective Patient-Physician Communication: Strengthening Relationships, Improving Patient Safety, Limiting Medical Liability[3] by Jane Ruddell outlines a curriculum in interpersonal and communication skills for physicians. Good communication skills with patients will reduce the number of malpractice suits, strengthen therapeutic relationships, and improve quality of care and patient satisfaction. Key components of Ruddell's work have been integrated into this text.

A supplemented version of the Interpersonal Skills and Communication section of the ACS Essentials booklet has been used to categorize the communication content of each of the cases (Table 4.1). This organizational structure can be utilized to initiate discussion and study of the interpersonal skills and communication competency in a surgical context.

More detailed explanations of these topics may be found in Ruddell's work cited above. Other helpful sources include "Developing Communication and Professionalism Competencies: A Guide for

Table 4.1 Interpersonal and Communication Skills and Cases

Skills	Cases
Listen actively with cultural, ethnic, gender, racial, age, and religious sensitivity	23, 39, 49
Communicate effectively with patients	1, 2, 3, 5, 6, 12, 20, 21, 22, 37, 38, 39, 45
Empathy	10, 29, 33, 34
Considering the patient's perspective	1, 2, 3, 5, 8, 11, 42
Choosing appropriate language	6, 10, 17, 26, 27, 39, 41, 48, 49
Discussing unknowns	7, 16, 19, 43, 50
Concern for health literacy, language, and cultural barriers	14, 17, 25, 30
Delivering bad news	13, 32, 44
Avoiding communication traps	18
Nonverbal communication	23, 53
Communicate effectively with families	21, 24, 27, 28, 35, 36, 37
Communicate effectively with professional associates and staff members	15, 18, 28, 34, 40, 45
Begin patient encounters, educate and advise patients, and end encounters, conveying sensitivity, compassion, and concern	48, 51
Discuss medical errors or professional mistakes honestly and openly in ways that promote patient learning	31, 52
Convey key information accurately to the transition team assuming care	27, 34, 36, 37
Appreciate and discuss sensitive issues with patients, including:	
Death and dying	9, 13
Health maintenance and disease prevention	12
Substance abuse	3
Deliver accurate, clear, and concise oral presentations	See Chapter 9, The Art of Oral Presentation

Surgeons," Cine-Med, Woodbury, CT, 2007; or the ACS course, Surgeons as Effective Communicators: Sharpening Skills for Critical Moments.

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Chapter 5
Professionalism in Surgery

Joel C. Rosenfeld MD, MEd and Linda L. Blank

Professionalism is the defining aspect of an occupation, which implies mastery of a complex body of knowledge and skills. Although many definitions exist, the common elements presume a commitment to competence, integrity, morality, and altruism over self-interest as well as a contract with society that strives to guarantee these qualities.[1–4] Central to the tenets of professionalism is the doctor's indefatigable commitment to provide humanistic patient care.[5]

The ACGME competency on professionalism states: "Residents must demonstrate a commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to a diverse patient population."[6]

In 1999, the American Board of Internal Medicine Foundation, American College of Physicians Foundation, and European Federation of Internal Medicine combined efforts to launch the Medical Professionalism Project.[7] These three organizations jointly developed a "physician charter," which provides a contemporary definition of professionalism that encompasses a set of principles to which all physicians should aspire. The charter identifies what physicians must do

Table 5.1 Professionalism and Cases

Professionalism Principles and Commitments	Cases
Principle of primacy of patient welfare • (ACS) Serve as effective advocates for our patients' needs • (ACGME) Demonstrate respect, compassion, and integrity	10, 35, 42
Principle of patient autonomy • (ACS) Encompass within our surgical care the special needs of terminally ill patients • (ACGME) Demonstrate commitment to ethical principles pertaining to provision or withholding of clinical care	2, 8, 9, 28,33
Principle of social justice • (ACS) Advocate strategies to improve individual and public health by communicating with government, health-care organizations, and industry • (ACGME) Demonstrate a responsiveness to the needs of patients and society that supersedes self-interest	32, 36, 39, 51, 52
Commitment to professional competence • (ACS) Participate in lifelong learning • (ACS) Maintain competence throughout our surgical careers • (ACS) Participate in self-regulation by setting, maintaining, and enforcing practice standards • (ACGME) Demonstrate a commitment to excellence and ongoing professional development	20, 43
Commitment to honesty with patients • (ACS) Disclose therapeutic options including their risks and benefits • (ACS) Fully disclose adverse events and medical errors • (ACGME) Demonstrate commitment to ethical principles pertaining to informed consent and business practices	5, 13, 15, 20, 31, 46, 53
Commitment to patient confidentiality • (ACS) Abide by the values of honesty, confidentiality, and altruism • (ACGME) Demonstrate commitment to ethical principles pertaining to confidentiality of patient information • (Hippocrates) What I may see or hear in the course of the treatment or even outside of the treatment in regard to the life of men, which on no account one must spread abroad, I will keep to myself, holding such things shameful to be spoken about.	6, 17, 18, 53

Table continues

Table 5.1 Professionalism and Cases—cont'd

Professionalism Principles and Commitments	Cases
Commitment to maintaining appropriate relations with patients • (ACS) Be sensitive and respectful of patients, understanding their vulnerability during the perioperative period • (ACS) Acknowledge patients' psychological, social, cultural, and spiritual needs • (ACS) Acknowledge and support the needs of patients' families • (ACGME) Demonstrate sensitivity and responsiveness to patients' culture, age, gender, and disabilities • (Hippocrates) Whatever houses I may visit, I will come for the benefit of the sick, remaining free of all intentional injustice, of all mischief and in particular of sexual relations with both female and male persons, be they free or slaves.	1, 4, 14, 23, 24, 26, 28, 35, 37, 41, 45
Commitment to improving quality of care • (ACS) Provide the highest quality of surgical care • (ACS) Improve care by evaluating its processes and outcomes	12, 14, 19, 21, 29, 38, 47, 48, 52
Commitment to improving access to care • (ACS) Provide necessary surgical care without regard to gender, race, disability, religion, social status, or ability to pay • (ACGME) Demonstrate a responsiveness to the needs of patients and society that supersedes self-interest	11, 52
Commitment to a just distribution of finite resources • (ACS) Work with society to establish a just, effective, and efficient distribution of health-care resources	51
Commitment to scientific knowledge	16, 19
Commitment to maintaining trust by managing conflicts of interest • (ACS) Disclose and resolve any conflict of interest that might influence the decisions of care	25
Commitment to professional responsibilities • (ACS) Respect the knowledge, dignity, and perspective of other health-care professionals. • (ACS) Participate in educational programs addressing professionalism • (ACS) Inform the public on subjects within our expertise • (ACGME) Demonstrate a commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to a diverse patient population	4, 22, 27, 30, 32, 34, 36, 40, 42, 44, 49, 50

to fulfill the commitments inherent in the profession's social contract, including placing the interests of patients above their own, setting and maintaining standards of competence and integrity, and providing expert advice to society on matters of health.[8,9]

Specifically, the charter articulates three fundamental principles and ten professional commitments:

Principles: (1) principle of primacy of patient welfare; (2) principle of patient autonomy; (3) principle of social justice

Commitments: (1) to professional competence; (2) to honesty with patients; (3) to patient confidentiality; (4) to maintaining appropriate relations with patients; (5) to improving quality of care; (6) to improving access to care; (7) to a just distribution of finite resources; (8) to scientific knowledge; (9) to maintaining trust by managing conflicts of interest; and (10) to professional responsibilities[9]

In 2003, the American College of Surgeons (ACS) similarly established a Task Force on Professionalism, which developed a Code of Professional Conduct for surgeons.[10]

The **Principles and Commitments of the Charter on Medical Professionalism,** the ACS Code of Professional Conduct, the **Oath of Hippocrates,**[11] and the **ACGME Definition of Professionalism** are represented by different colors in Table 5.1. The similarity of these four ethical codes is readily apparent. In each chapter of this book, the surgeon-contributor included a section about professionalism that pertains to the case discussed. Table 5.1 lists these contributions aligned with the most relevant professionalism principles and/or commitments.

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Chapter 6
Systems-Based Practice

Stephen E. Gordon MBA, John R. Clarke MD, Stephen K. Klasko MD, MBA, Linnea S. Hauge PhD, and Barry D. Mann MD

The Accreditation Council on Graduate Medical Education has defined competency in systems-based practice (SBP) as follows: "Residents must demonstrate an awareness of and responsiveness to the larger context and system of health care and the ability to effectively call on system resources to provide care that is of optimal value."[1]

Each case in this textbook includes a component of how provision of surgical care intersects with the larger health-care system. These SBP ideas have been organized into three broad categories: The System, Improving System Function, and Health-Care Policy and Business (see Table 6.1).

COMPONENT I: THE SYSTEM

This category includes examples of how health-care providers—physicians, nurses, technicians, hospitals, and health systems—coordinate and deliver care at many different levels. The surgical cases provide the backdrop for examining a variety of systems issues in surgery, such as operating room dynamics, interdisciplinary team collaboration, and the prioritization system for transplant recipients.

Health-care costs and the costs of surgical procedures are addressed, including the way in which these costs are assigned and managed. Cost drivers are the actual resource-intensive activities that drive up overall health-care costs, not just the price charged for a specific service. The largest cost drivers of health care are length of stay, drugs, supplies, and staffing.

By the year 2007, national health-care expenditures reached $2.1 trillion, and 16 cents of every dollar spent in the United States went toward health care. The cost of the system has made it impossible for the clinical provider to ignore the enormous costs of providing care to patients. An appropriate awareness of costs can help physicians contribute to the overall efficiency of the health-care system and may ultimately improve access. Accordingly, the prices of services appear throughout this book to raise awareness of costs typically associated with certain tests and procedures and incurred by patients, insurers, and health-care organizations. Prices may be inconsistent, as they are indeed inconsistent throughout the country.

Basic ideas behind cost are included: the difference between direct and indirect, and variable and fixed costs; the extraordinarily high fixed cost nature of a hospital; the importance of understanding the reality of "opportunity" costs with regard to infrastructure; and the difference between reimbursement and cost.

COMPONENT II: IMPROVING SYSTEM FUNCTION

This category includes examples of how surgeons can work to improve the system, especially: (1) systematization of practices and information; (2) using clinical information technology to improve efficiency; (3) enhancement of collaboration; (4) more efficient business practices; and (5) attention to patient safety to improve outcomes and limit unnecessary care.

COMPONENT III: HEALTH-CARE POLICY AND BUSINESS

The third category of systems-based ideas highlights aspects of surgical practice that intersect with government and business—public health, health care law, and the business of medicine. Care applications of public health concepts demonstrate surgeons' efforts to prevent disease through screenings, education, and intervention. Health-care law case

Table 6.1 Systems-Based Practice and Cases

Systems-Based Concept	Cases
The System	
Provider operations and coordination	2, 4, 16, 17, 21, 27, 28, 31, 36, 37, 42, 49
Costs and cost drivers	1, 9, 14, 19, 26, 30
Reimbursement and insurance	7, 23, 26, 41, 43, 44, 52
Improving System Function	
Systematization of practices	10, 11, 13, 32, 35, 38, 40, 51
Utilization of information technology	6, 15
Process improvement	5, 25, 27, 30, 45, 47, 48
Patient safety	17, 21, 22, 24, 27, 29, 37, 38, 46, 47, 53
Health-Care Policy and Business	
Public health	12, 39
Health-care law	8, 18
Business of medicine	2, 14, 20, 30, 33, 44, 50, 52

examples address practice regulations, the Health Insurance Portability and Accountability Act (HIPAA), and physician liability. Principles of marketing, accounting, and negotiations are also introduced in cases throughout this book (Table 6.1).

All Systems-Based boxes can be downloaded as a single .pdf file (a "vertical read" of the competency) from the online version of this book.

Reference

1. Accreditation Council on Graduate Medical Education: General Competencies. Available at http://www.acgme.org/outcome/comp/compFull.asp

Chapter 7
How to Succeed on the Surgical Clerkship
Thoughts on Expectations, Feedback, and Stress

Kimberly D. Schenarts PhD and Paul J. Schenarts MD

EXPECTATIONS FOR STUDENTS

Success on a surgical clerkship is built on hard work. Achieving success requires that you be **ADEPT.**

Attention to Detail. Careful attention to detail is key to your success. Knowing your patients and keeping up to date on their daily progress is your primary responsibility. You need to be your patients' champion and ensure that you have the most reliable information available for participating in decisions about their care. Additionally, a competent physician is well read and well informed about his or her patients' diseases.

Dependability. Being on time, prepared, and following through on assigned tasks is the cornerstone of professionalism and is vital to the well-being of your patients. You won't be expected to know everything; however, if you are asked a question and you don't know the answer, be honest. Say, "I don't know," find the answer to the question, and report back.

Effort. Giving your best physically, emotionally, and intellectually when you are working extraordinary hours may at times seem a Herculean task. However, effort you invest will affect how you experience the clerkship and how you are perceived by your team.

Privilege. Being a physician is a privilege. You will have intimate knowledge about your patients and they will count on your integrity. Patients and their families will remember your words, the tone of your voice, and the way you looked, and these impressions will impact how your patients perceive you and trust the care that you provide.

Team Player. Be the person that everyone wants on their service. Do what is asked of you, and go the extra mile. If a team member needs help, ask what you can do. A highly synchronized team is the key to optimal patient care.

FEEDBACK

A common concern among medical students is that they do not receive enough feedback about their performance. In an ideal world, your residents and attendings will view providing feedback as one of their important responsibilities and will schedule time to sit down with you to discuss their impressions; in the real world, that is not always the case. If you do not receive feedback, it is your responsibility to ask for it. Simply say, "Dr. X, do you have a few minutes to sit down with me to tell me what I can do in our remaining time together to improve my performance?" Most of your clinical teachers will be happy to tell you what you can do to improve and will be impressed by your desire to improve.

How do you prepare to receive and use feedback? When you receive feedback, prepare yourself for the possibility that you may receive information that is in conflict with how you have perceived your performance. Keep an open mind, listen without interrupting, and believe that the intent of the feedback is to help you improve your performance. Ask for specific examples to help you understand where and how your performance needs improvement.

STRESS

Stress is inevitable, and most student have, by this point in their academic careers, developed appropriate coping mechanisms. However, the stress of being a medical student on a clerkship is significant: studying complicated material, working long hours, trying to meet the demands of many masters, dealing with death and dying, and trying to maintain your relationships, all the while taking care of your basic needs. It's easy to be overwhelmed and important to distinguish between situationally specific stress and stress that is continuous and all-encompassing. If you feel the latter, seek help immediately from a faculty member or student counseling services.

At times you simply need to **BREATHE.**

Be Yourself. Superman and Wonder Woman are fictional. Do the best you can; that is all anyone can ask.

Read. Set a reading schedule and stick to it. If you don't achieve your goal one day, force yourself to double up the next day. Use practice exams to test your knowledge. Know what works for you—study groups or studying on your own.

Eat Well and Exercise. Don't fall prey to late-night, high-carbohydrate meals on a regular basis. And even though you are on your feet all day, do something, anything, to get the blood flowing and the endorphins rushing.

Attitude. A positive attitude will not only make you feel better, but will help you put things into perspective. If you expect the best, you usually find it.

Time Out. Take time out to be with friends and/or family or just reflect. You will find this break invigorating and rejuvenating.

Humor. It is one of the great coping tools of all time. Laugh out loud. Appreciate the absurdity that rears its head in everyday life.

Enjoy. Enjoy what you are doing. Take time to embrace all that you have learned in such a short time and take pride in those achievements.

Chapter 8
The Resident as Teacher: Facilitating Student Success

Thoughts on Expectations, Feedback, and Stress

Paul J. Schenarts MD and Kimberly D. Schenarts PhD

SETTING EXPECTATIONS

- Clarify for the students your expectations and their role on the team during the first or second day of the rotation. The more integrated students feel, the more effective they can be as members of the team.
- Assign students to individual patients for whom they will be responsible for daily notes and knowing their medical issues.
- Set defined tasks that are educational and will also benefit the team, such as looking up the use of a new medication or treatment protocol.
- Ask questions with an educationally productive purpose—to clarify information, to assess a student's understanding, to engage learners in a decision-making process. Avoid using questions to establish your authority.
- Schedule at least one session a week to review important topics in a small group (i.e., acid-base, vent management, cardiac monitoring).

- Use time at the scrub sink, on the wards, and in the operating room to teach on the fly. If a patient's workup was completed as an outpatient, does the student understand the indications for surgery and the details of the previous workup?
- Give students enough advance notice about which surgeries they will attend so they can read about the case.
- Tie service to education. If a student retrieves a film for you, review the film with the student and explain the findings.

GIVING FEEDBACK

- Review students' notes before you co-sign them. The written word will often provide insight into a student's clinical reasoning skills. Has the student simply recorded the data or has he or she synthesized and developed a plan. Co-signing a note is an opportunity for feedback.
- Let students know early in the rotation if they are meeting expectations and what they can do to improve their performance.
- When providing feedback, begin with your positive feedback first and then progress to areas needing improvement.
- Provide concrete and reasonable goals for student performance. Follow up with the student and discuss progress made.

REDUCING STRESS

On the surgery clerkship, physical demands of long hours and emotional involvement with surgical patients creates heightened stress among medical students. As a resident you can help to decrease student stress with some simple actions:

- Call the students by their proper names and include them as welcome members of the team.
- Be approachable and serve as a mentor; avoid being an additional source of stress.
- Ask frequently if there are things they feel they need to learn or understand. Provide helpful and concise explanations.
- Be aware of your students' well-being: be sure they have consistent opportunities to eat, rest, and learn.

Chapter 9
The Art of Oral Presentation

Paul J. Schenarts MD *and Mary Ann Hopkins* MPhil, MD

Communication skills form the basis of medicine. Throughout your entire career, you will communicate crucial medical information with your colleagues. It is therefore critical to strive for effective verbal communication, with the emphasis on prioritizing and adjusting to the particular situation the amount of information transmitted.

Often the only presentation format medical students learn is the “History and Physical.” Presenting a case in this format in the middle of the night is not the most efficient means to present information verbally. Your job in verbal communication is to distill and synthesize the major points of the history and physical so that the listener can be focused from the beginning of the conversation, can visualize the patient whom you describe, and can understand your differential diagnosis and thought process. You may add or omit particular details depending on the setting in which the presentation is given. During teaching rounds, demonstrating your detailed understanding of the issues of the case will be appropriate, while in the middle of the night the ability to distill and synthesize the major points will be most effective and appreciated.

The ability to trim a presentation to the most essential elements requires that you understand which facts are high and low priority and when to incorporate them into your presentation. One trick is the appropriate use of “buzz” words, which will immediately focus the listener. Most surgeons, for example, will have an immediate response to statements such as “free air” or “pain out of proportion to exam.” Keep a small notebook of meaningful phrases and buzz words.

ADJUSTING THE LEVEL OF DETAIL

Your goal is to paint a clear and complete picture of the situation in a short amount of time. Every presentation should contain the most essential information. Depending on the context you may wish to expand your presentation to include finer points of detail (i.e., teaching rounds); however, even when giving condensed presentations, you should be able to demonstrate your complete knowledge of the case, in the event the listener asks for further detail.

When presenting orally, avoid getting lost in the details of the complicated medical history. Paint a background and then follow with a focus on the patient's current presentation. For example:

- For the complicated patient with diabetes mellitus, atherosclerotic cardiovascular disease, congestive heart failure, and end-stage renal disease (ESRD) who presents with appendicitis, start: *"On a background of medical disorders including, diabetes mellitus, atherosclerotic cardiovascular disease, congestive heart failure, and ESRD, this 73-year-old male presents with RLQ pain."*
- For a patient with small bowel obstruction (SBO) due to adhesions, who has had previous colon resection, and two previous lyses of adhesions, start: *"On a background of multiple previous operations, this patient presents with distention consistent with SBO due to adhesions."*

DISTILLATION

This is particularly difficult in the complicated patient. One technique is to include only parts of the past medical history that will influence your decision making, such as coronary artery disease (the patient may need invasive monitoring) or ESRD (the patient may have an electrolyte imbalance or may have recently had dialysis).

SYNTHESIS

Provide a clear, concise chronological history that includes positive findings and pertinent negatives. Bring together the essential elements of the history, examination, laboratory data, and radiographic data into a unified diagnosis and remember to propose a treatment plan.

In the example on the next few pages, aspects of a typical history and physical have been highlighted. High-priority findings and buzz words appear in red type. Important but lower-priority details are in blue type. Review the differences between three working situations: the 1 AM call to wake your attending, the 7 AM report to your chief resident, and 3 PM teaching rounds. Notice how these high- and lower-priority elements are incorporated into different types of presentations.

Typical Written History and Physical

NOTE THE HISTORY AND PHYSICAL BELOW AND THE THREE DIFFERENT ORAL PRESENTATIONS ON THE FACING PAGE USING THE SAME DATA POINTS.

Chief Complaint: 53-year-old male with hx of peptic ulcer disease (PUD) presents with abdominal pain

HPI: The patient is a 53-year-old male with a history of a duodenal ulcer who underwent endoscopy 3 weeks ago and was found to have an ulcer in the anterior wall of the first portion of the duodenum. He was placed on H_2 blockers and antibiotics and scheduled for follow-up in 2 weeks. He has been having intermittent epigastric pain for 2 weeks, somewhat relieved by milk and antacids, but noted the acute onset of severe pain about 12 hours ago. He admits to drinking a six-pack of beer almost every evening and admits noncompliance with medication. He increased his drinking to alleviate the pain. He was found on the floor writhing in pain by his son and brought to the ER at midnight. He denies any nausea, vomiting, or fevers. Pertinent positive and negatives include a colonoscopy 3 years ago that was reportedly normal, no hx of weight loss or carcinoma.

PMH: hypertension, PUD; denies DM, CAD **PSH:** none

Meds: HCTZ, Maalox, Zantac (noncompliant)

Allergies: NKDA

Family History: smokes $1^1/_2$ PPD × 25 years; drinks 6 beers daily; denies recreational drugs; divorced father of 2; lives alone; works in construction

ROS: CV, GU, NEURO unremarkable; GI as in HPI

PE: VS: T = 100.8, P = 120, R = 20, BP = 110/60

Gen: WDWN male in moderate distress; ETOH on breath

HEENT: unremarkable

Neck: supple; no JVD

CV: RRR no M/R/G

Chest: BS clear bilaterally

Abd: distended, rigid with involuntary guarding; rebound; BS hypoactive, no masses/scars appreciated

Rectal: nl tone, no masses, prostate nl, no nodules, stool: hemocult trace+

Genitalia: penis and testes WNL

EXT: no clubbing, cyanosis or edema. Fem, DP, PT pulses all 2+

Neurological exam: alert, oriented; cranial nerve exam wnl; no gross motor or sensory deficit

Labs: WBC = 18, Na = 135, K = 3.2, CL = 110, CO_2 = 19

AXR/CXR: free air under the diaphragm

Assessment: 53-year-old male with an acute abdomen and free air under the diaphragm with probable perforated duodenal ulcer; doubt diverticulitis or other reasons for free air

Plan:

1. Aggressive fluid resuscitation with LR; prophylactic antibiotics; K^+ supplementation; to OR for immediate exploration.
2. Monitor post-op for hypertension and place back on HCTZ when appropriate.

Oral Presentations Appropriate for Different Contexts

1 AM call to attending surgeon	Dr. Jones, sorry to wake you; this is Jim Smith. I have a 53-year-old male in the ER with free air. He's a drinker who had a documented ulcer on endoscopy 2 weeks ago. He was put on H_2 blockers, but has been noncompliant. He developed severe pain 12 hours ago and now has diffuse peritonitis. He's on HCTZ for hypertension and his K^+ is 3.2. He's hypovolemic so I'm giving him volume and K^+ and getting him ready for the OR.
7 AM morning work rounds	The patient is a 53-year-old male who presented last night in the ED with free air. He drinks heavily and had a documented ulcer on endoscopy 2 weeks ago. He experienced severe abdominal pain 12 hours prior to admission to the ED and presented with diffuse peritonitis. His K^+ was 3.2, probably related to HCTZ, and he required replacement. On exam he was hypovolemic. We took him to the OR, lavaged the abdomen, and performed a Graham patch over a 1.0-cm ulcer on the anterior wall of the duodenum just beyond the pylorus. He's alert, breathing well. His VS this AM are T = 99.8, P = 100, BP = 144/95, RR = 18. Since the OR he's had 2,500 mL of RL and he's produced 500 mL of urine and his NG output has been minimal. He's now making about 40 mL urine/hr. He's on Unasyn and Flagyl. His repeat K^+ after being given 40 mEq KCl is 4.3. Because of his alcohol history we have started him on lorazepam and will monitor him for DTs. When he is more stable, we will resume his antihypertensive meds as needed.
3 PM teaching rounds	The patient is a 53-year-old male who presented last night in the ED with free air under the diaphragm. He has a history of heavy alcohol use and had a documented duodenal ulcer on endoscopy 2 weeks prior to admission and had been given H_2 blockers and antibiotics, which he had not been taking regularly. He experienced severe pain 12 hours prior to admission to the ED and presented with diffuse peritonitis. His past hx is significant for hypertension for which he was on HCTZ. On exam he was hypovolemic—manifested by tachycardia, hypotension, and decreased urine output. He was taken to the OR last night and was found to have a perforation in the first part of the duodenum, just beyond the pylorus. The abdomen was lavaged and a Graham patch was placed over a 1.0-cm ulcer on the

anterior wall of the duodenum. Postoperatively, he has done well and is now making adequate urine and his heart rate is in the 90s. He has also been placed on benzodiazepines as prophylaxis for alcohol withdrawal.

The discussion in the OR centered on two main issues: should an acid-reducing procedure, such as a vagotomy and pyloroplasty, parietal cell vagotomy, or vagotomy and antrectomy be performed, and if so, which one? Our considerations were that he had been noncompliant with his H_2 blockers and therefore we considered performing a vagotomy and pyloroplasty. But since we knew his acute pain had begun about 12 hours prior to admission and the peritoneal contamination was very significant, we decided it best simply to perform a Graham patch—the literature says that about 6 hours following perforation appears to be the interval after which one shouldn't perform a definitive acid-reduction procedure.

Editor's note: Each conversation integrates the important data points from the H & P. The 1 AM conversation gets to the point immediately beginning with "free air"; the attending understands immediately that she needs to get out of bed. The 7 AM report focuses on what happened, how it was corrected, and the current status of the patient. The 3 PM "teaching rounds" raises two major discussion points of the case and allows the student to demonstrate knowledge, synthesis, and the application of evidence-based medicine.

Appendix 1
ACGME General Competencies

ACGME GENERAL COMPETENCIES VERSION 1.3 (9.28.99)

The residency program must require its residents to develop the competencies in the six areas below to the level expected of a new practitioner. Toward this end, programs must define the specific knowledge, skills, and attitudes required and provide educational experiences as needed in order for their residents to demonstrate the competencies.

Patient Care

Residents must be able to provide patient care that is compassionate, appropriate, and effective for the treatment of health problems and the promotion of health. Residents are expected to:

- communicate effectively and demonstrate caring and respectful behaviors when interacting with patients and their families
- gather essential and accurate information about their patients
- make informed decisions about diagnostic and therapeutic interventions based on patient information and preferences, up-to-date scientific evidence, and clinical judgment
- develop and carry out patient management plans
- counsel and educate patients and their families
- use information technology to support patient care decisions and patient education
- perform competently all medical and invasive procedures considered essential for the area of practice
- provide health care services aimed at preventing health problems or maintaining health
- work with health care professionals, including those from other disciplines, to provide patient-focused care

Medical Knowledge

Residents must demonstrate knowledge about established and evolving biomedical, clinical, and cognate (e.g., epidemiological and social-behavioral) sciences and the application of this knowledge to patient care. Residents are expected to:

- demonstrate an investigatory and analytic thinking approach to clinical situations
- know and apply the basic and clinically supportive sciences which are appropriate to their discipline

Practice-Based Learning and Improvement

Residents must be able to investigate and evaluate their patient care practices, appraise and assimilate scientific evidence, and improve their patient care practices. Residents are expected to:

- analyze practice experience and perform practice-based improvement activities using a systematic methodology
- locate, appraise, and assimilate evidence from scientific studies related to their patients' health problems
- obtain and use information about their own population of patients and the larger population from which their patients are drawn
- apply knowledge of study designs and statistical methods to the appraisal of clinical studies and other information on diagnostic and therapeutic effectiveness
- use information technology to manage information, access on-line medical information, and support their own education
- facilitate the learning of students and other health care professionals

Interpersonal and Communication Skills

Residents must be able to demonstrate interpersonal and communication skills that result in effective information exchange and teaming with patients, their patients' families, and professional associates. Residents are expected to:

- create and sustain a therapeutic and ethically sound relationship with patients
- use effective listening skills and elicit and provide information using effective nonverbal, explanatory, questioning, and writing skills
- work effectively with others as a member or leader of a health care team or other professional group

Professionalism

Residents must demonstrate a commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to a diverse patient population. Residents are expected to:

- demonstrate respect, compassion, and integrity; a responsiveness to the needs of patients and society that supersedes self-interest; accountability to patients, society, and the profession; and a commitment to excellence and ongoing professional development
- demonstrate a commitment to ethical principles pertaining to provision or withholding of clinical care, confidentiality of patient information, informed consent, and business practices
- demonstrate sensitivity and responsiveness to patients' culture, age, gender, and disabilities

Systems-Based Practice

Residents must demonstrate an awareness of and responsiveness to the larger context and system of health care and the ability to effectively call on system resources to provide care that is of optimal value. Residents are expected to:

- understand how their patient care and other professional practices affect other health care professionals, the health care organization, and the larger society and how these elements of the system affect their own practice
- know how types of medical practice and delivery systems differ from one another, including methods of controlling health care costs and allocating resources
- practice cost-effective health care and resource allocation that does not compromise quality of care
- advocate for quality patient care and assist patients in dealing with system complexities
- know how to partner with health care managers and health care providers to assess, coordinate, and improve health care and know how these activities can affect system performance

Appendix 2
Competency Assessment Forms

Students and Residents: When assessing a complication, fill out this form in consultation with each other and with your attending. (You can photocopy this form or download it as a Word document from the book's Web site on www.studentconsult.com.)

Practice-Based Learning and Improvement: Morbidity and Mortality Self-Assessment Form	
Complication	
Type	
Surgery performed	
Patient's disease	
Presentation	
Intervention	
Outcome	
Risk factors	
How were risks addressed?	
What happened?	
What could have been done differently?	
Would outcome have been different?	

Competency Self-Assessment Form

Patient Summary:

Dx:

Patient Care

Was I thorough? How can I make my clinical reasoning more sound?

Medical Knowledge

What basics could I know better? Did I read and learn for this case?

Practice-Based Learning and Improvement

Did I utilize evidence-based medicine? Am I improving as I practice?

Interpersonal and Communication Skills

Did I work together effectively and communicate clearly with my colleagues? Was I respectful and compassionate in my interactions with my patient and his/her family?

Professionalism

Was I attentive to the welfare of my patient? Am I considerate of the needs of my fellow students/housestaff?

Systems-Based Practice

Could the system have worked better? How can I help to facilitate improvements?

This Competency Self-Assessment Form can be copied or downloaded as a Word document from the book's Web site on www.studentconsult.com to enable you to create your own competency-based patient-encounter portfolio. This icon appears at the end of each section of this book as a reminder of the importance of self-evaluation.

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Chapter 10
Radiology Tools for Abdominal Diagnosis

Anton Mahne MD, *Andrew J. Curtin* MD,
and Harry G. Zegel MD

Radiology and the Competencies

Patient Care
Provide safe and efficient patient care by appropriately utilizing diagnostic and/or interventional radiology techniques.
Medical Knowledge
Engage in continuous learning, using current evidence to select appropriate diagnostic and/or therapeutic radiology techniques for optimal patient care.
Practice-Based Learning and Improvement
Evaluate your own performance utilizing scientific data. Consult a radiologist when unclear about the "best test" for your patient in order to maximize your learning experience while optimizing patient care.
Interpersonal and Communication Skills
Explain to your patient the nature of any radiological study ordered, and obtain informed consent, if required.
Professionalism
Communicating the results of the study/procedure to your patient and appropriate team members in a timely manner demonstrates compassion, honesty, and empathy to your patient and professional regard for your colleagues.
System-Based Practice
Learn how your in-patient and out-patient system functions. Utilize imaging resources in a cost-effective manner, while maintaining a high standard of patient care. Spend your health-care dollar wisely.

The Obstruction Series

The *obstruction series* is usually the first radiographic investigation utilized in the evaluation of patients presenting with abdominal pain, distention, or bowel obstruction suspected by history and physical examination. It is useful as a follow-up study in patients with known bowel obstruction, and can be helpful in differentiating ileus versus obstruction in patients who have undergone abdominal surgery.

The obstruction series consists of three radiographs:

1) Chest radiograph (erect)
2) Supine abdominal radiograph
3) Erect abdominal radiograph or left lateral decubitus (if the patient is too ill to stand erect)

1. Chest Radiograph (PA)

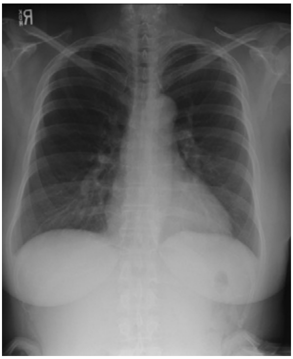

Figure 10-1 Normal chest x-ray.

The following mnemonic may be helpful to remind you of what to look for on a chest radiograph:

Airway: trachea, bronchi, lung fields
Bones: clavicles, ribs, scapulae, spine
Cardiac: heart, mediastinum, pulmonary vasculature
Diaphragm: costophrenic and costocardiac angles, free air
Everything else: endotracheal, nasogastric and chest tubes; central lines, upper abdomen

Specific abnormal findings to look for on the chest x-ray:

- Free air under the diaphragm
- Pneumonic infiltrates
- Pneumothorax
- Pleural effusions
- Calcifications
- Pulmonary nodules
- Presence and position of tubes/catheters (e.g., central venous catheters, endotracheal tubes, chest tubes, and pacemakers)

2. Supine Abdominal Radiograph—Normal Anatomy (AP)

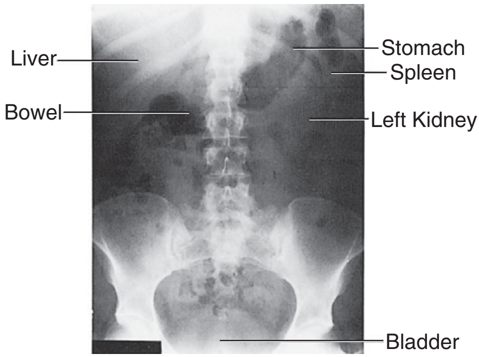

Figure 10-2 Note that specific organs can often be delineated on the supine abdominal radiograph.

When viewing abdominal radiographs, it is important to evaluate for:

1. Gas pattern
2. Air-fluid levels
3. Extraluminal air
4. Calcifications
5. Masses
6. Lines and tubes

3. Erect Abdominal Film (AP)

The erect abdominal radiograph is utilized to detect air-fluid levels in the GI tract, and “free” (extraluminal) intra-abdominal air. It is normal to have an air-fluid level present in the stomach on an erect film. Normally, minimal small bowel air is present and the small intestine should measure no more than 2.5 to 3.0 cm in diameter, with centrally located loops. The large bowel is located more toward the periphery of an abdominal radiograph, as the right colon, hepatic flexure, splenic flexure, and left colon generally have a fixed position. If a patient is too ill for an erect radiograph, a left lateral decubitus radiograph may be obtained.

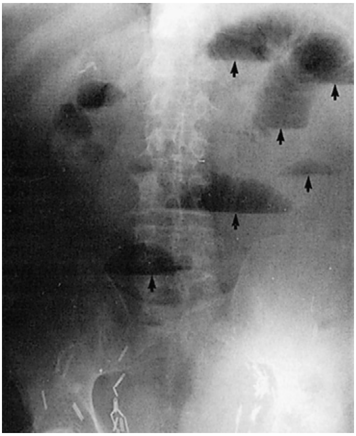

Figure 10-3 Note the numerous air-fluid levels, which will be seen only on the upright view. The patient proved to have a small bowel obstruction due to adhesions.

Table 10-1 Calcifications Seen on Abdominal X-rays

Entity	Notes
Gallstones	10% of gallstones are radiopaque. May be incidental finding.
Appendicolith	Its presence is associated with appendicitis.
Chronic pancreatitis	Multiple calcifications in pancreas.
Abdominal aortic aneurysm	Look for calcium in aortic wall.
Nephrolithiasis/ureterolithiasis	Stones may be apparent overlying kidney shadow. Ureteral stones may appear anywhere along course of ureter.
Gallstone “ileus”	A gallstone large enough to block the ileocecal valve enters the bowel via a biliary enteric fistula from the gallbladder to the duodenum; usually the result of untreated chronic cholecystitis.
Uterine fibroids	Calcified fibroids may appear in pelvis.
Dermoid cysts	A dermoid is a mature teratoma that may manifest as a calcified “tooth” in pelvis.

Extraluminal Air: “Free Air”

Free Air (extraluminal air) is a seminal surgical concept as its presence is indicative of a perforated viscus and generally constitutes a surgical emergency. (There are “benign causes.” See Case 7.) Remember that postoperative patients, especially those who have undergone laparoscopic procedures, may have residual air/CO_2 in their abdominal cavity.

Common Causes of "Free Air"

- Stomach
  - Perforated ulcer
  - Perforated cancer
- Duodenum
  - Perforated ulcer
- Small bowel
  - Strangulated obstruction
  - Crohn's disease
- Cecum
  - Commonly related to cecal dilatation due to a more distal obstruction
- Large bowel
  - Diverticulitis
  - Cancer
- Anastomotic breakdown
- Air related to recent surgery

Figures 10-4 and 10-5 show how free air may appear on radiographs.

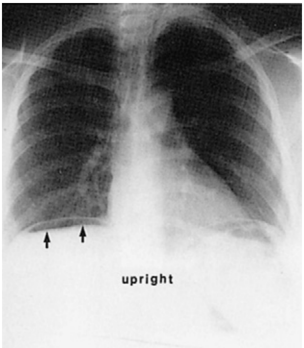

Figure 10-4 The upright chest x-ray shows free air under the right hemi-diaphragm.

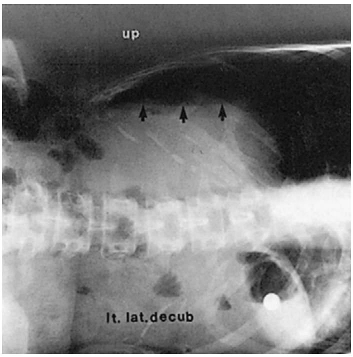

Figure 10-5 Left lateral decubitus. Free intraperitoneal air is demonstrated over the liver (*arrows*). This positioning is helpful when the patient cannot tolerate an upright study.

Right Upper Quadrant Ultrasonography and the HIDA Scan

Right Upper Quadrant Ultrasonography

For patients presenting with a history suggestive of biliary disease, right upper quadrant ultrasonography (RUQ US) is usually performed to evaluate the gallbladder and surrounding structures. Table 10-2 describes what the sonographer will commonly evaluate in a RUQ US.

Table 10-2 Right Upper Quadrant Ultrasonography

Structure	What to Look for and Evaluate on Sonographic Images
Liver	Echotexture, masses/cystic lesions, intrahepatic ductal dilatation
Gallbladder	Size, wall thickness, pericholecystic fluid, gallstones
Bile ducts	Intra/extrahepatic ductal dilatation
Kidneys	Size, calyceal dilatation, perinephric fluid, nephrolithiasis
Pancreas	Masses, cysts, calcifications, peripancreatic fluid
Fluid	Ascites, pleural effusion, focal loculation
Vessels	Dilatation, thrombosis, aneurysms

Figures 10-6 through 10-8 illustrate the potential sonographic findings that may be seen in:

1. Cholelithiasis without cholecystitis

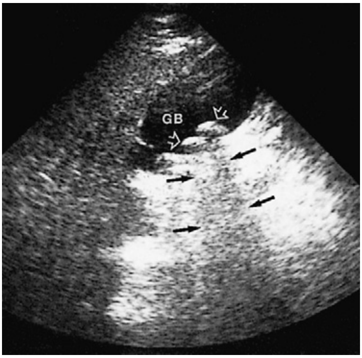

Figure 10-6 Stones and shadowing. Ultrasound image of the gallbladder: There are two echogenic gallstones (*open arrows*) in the gallbladder (GB) lumen. Note the posterior acoustical shadowing (*black arrows*).

2. Acute cholecystitis—thickened gallbladder wall

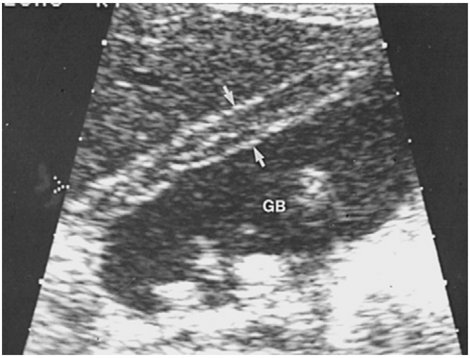

Figure 10-7 The thickening (6–8 mm) of the gallbladder wall (*arrows*) has a sonolucent and striated appearance consistent with acute cholecystitis. Gallstones can be seen in the gallbladder lumen.

3. Common bile duct obstruction

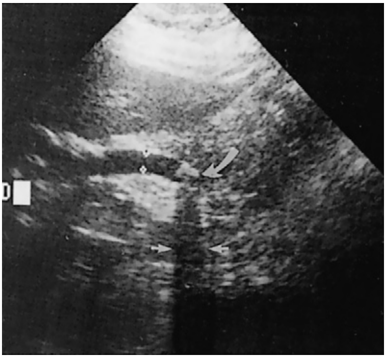

Figure 10-8 Ultrasound image of the distal common bile duct. A single echogenic stone (*curved arrow*) is present in the dilated distal common bile duct. Posterior acoustical shadowing (*arrows*) is also noted.

The HIDA Scan (Hydroxyl Iminodiacetic Acid Scan)

When a clinical diagnosis of acute cholecystitis is entertained, but not established unequivocally by ultrasonography, radionuclide scanning of the biliary system with Tc^{99}-labeled radiotracers may provide additional information. In the appropriate clinical setting, nonvisualization of the gallbladder is suggestive of cystic duct obstruction and (by inference) acute cholecystitis (Figure 10-9).

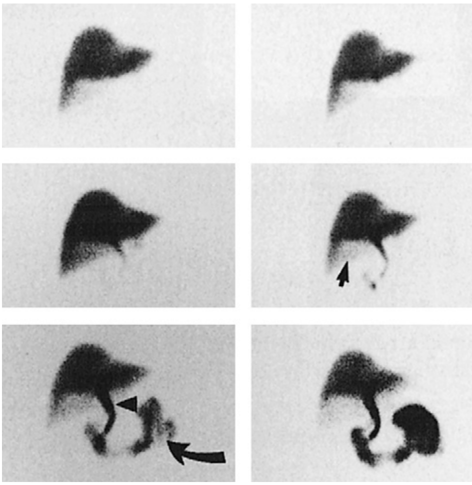

Figure 10-9 Hepatobiliary nuclear medicine scan: acute cholecystitis. Radiotracer is excreted in a normal manner into the extrahepatic bile ducts (*arrowhead*). The gallbladder fossa (*arrow*) shows no increase in activity, which is diagnostic of an obstructed cystic duct. Excretion of the radiotracer into the small bowel (*curved arrow*) indicates patency of the common bile duct.

CT of the Abdomen and Pelvis

CT of the abdomen and pelvis is used to evaluate patients presenting with abdominal pain, fever, masses, and weight loss, and to stage oncologic disease. Images are acquired in the cross-sectional plane. When viewing these images, imagine that you are at the foot of a patient's bed and are looking up toward the head, viewing slices from different levels. Computer images may be reformatted in sagittal or coronal planes.

Oral contrast is used to opacify the bowel. **Intravenous contrast** is used to opacify the vasculature and to differentiate abnormalities in solid parenchymal organs.

The use of iodinated intravenous contrast is generally safe in patients with a serum creatinine of ≤1.5 mg/dL. It is important to know whether the patient has an allergy to iodine or shellfish, has a history of asthma, or has had an adverse reaction to iodinated contrast. In such cases, a pre-procedure steroid preparation may be necessary.

A radiologist evaluates CT images systematically in soft tissue, lung, and bone windows.

Normal cross-sectional anatomy is demonstrated in Figures 10-10 and 10-11.

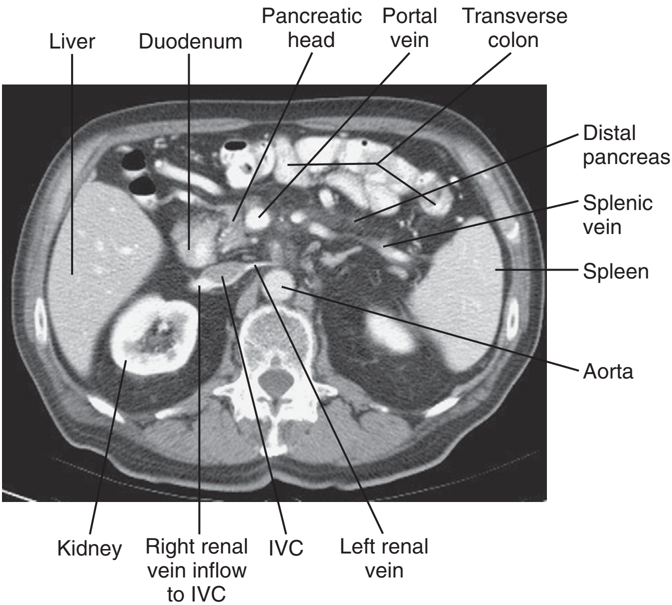

Figure 10-10 Normal CT focusing on upper abdomen.

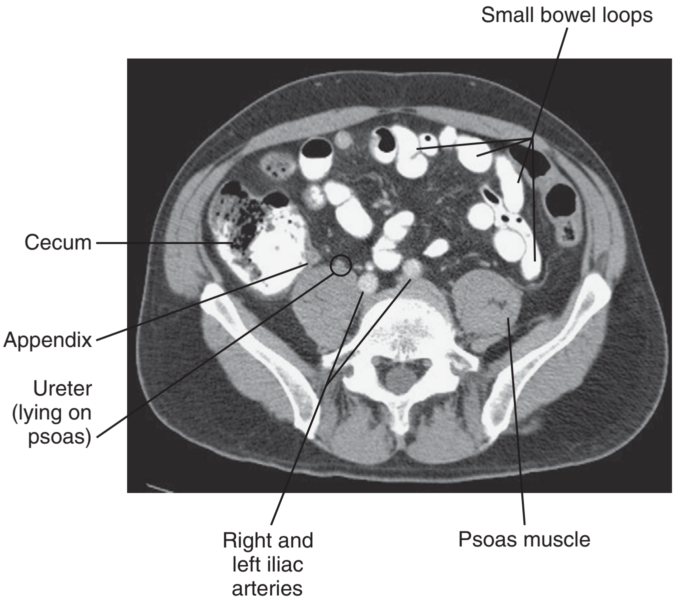

Figure 10-11 Normal CT focusing on lower abdomen/pelvis.

Figures 10-12 through 10-17 demonstrate common pathologic conditions.

Figure 10-12 Acute appendicitis. Note dilatation of the appendix (*asterisks*) surrounded by the edematous appendiceal wall. The arrow points to a small appendicolith.

Figure 10-13 Acute appendicitis. The appendix (*arrow*) is dilated with a thickened wall owing to mural edema.

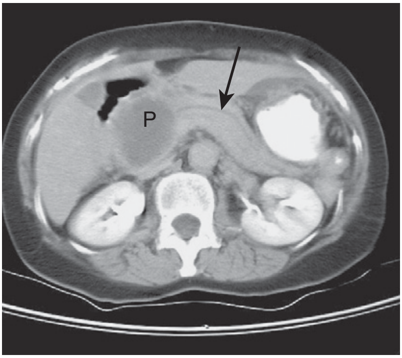

Figure 10-14 Pancreatic pseudocyst. P marks a pseudocyst occupying the head of the pancreas. The pancreatic duct (*arrow*) is dilated.

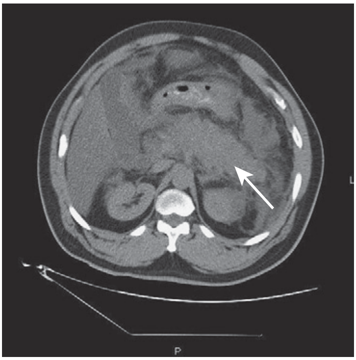

Figure 10-15 Pancreatitis. A slightly enlarged, poorly marginated pancreas is seen with surrounding edema and reactive fluid in the retroperitoneal space.

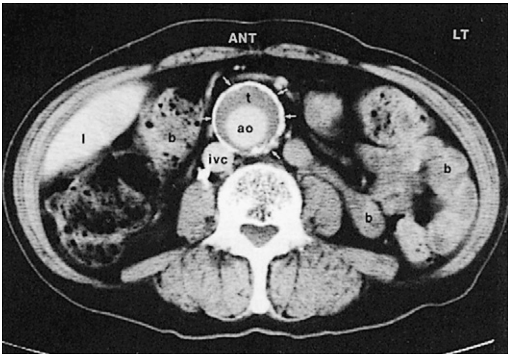

Figure 10-16 Nonruptured abdominal aortic aneurysm. Note the calcified aneurysmal wall of the abdominal aorta (*arrows*). Thrombus (t) is apparent in the aortic lumen. Bowel (b) and liver (l) show contrast enhancement.

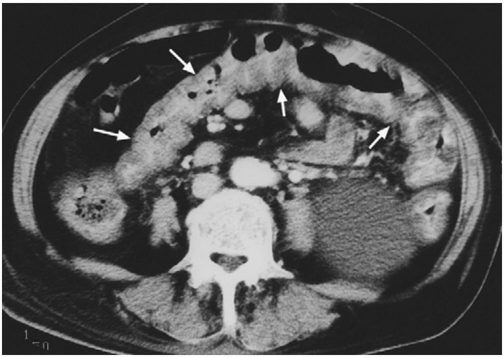

Figure 10-17 Pseudomembranous colitis. The thickening of the colonic wall (*arrows*) from the ascending colon through the transverse to the descending colon is consistent with a diffuse colitis.

Chapter 11
Right Lower Quadrant Pain in a 28-Year-Old Female (Case 1)

Barry D. Mann MD and Michael Belden MD

Differential Diagnosis

Appendicitis	Ectopic pregnancy	Ruptured ovarian cyst	Crohn's disease	Ureterolithiasis
Mesenteric adenitis	Pelvic inflammatory disease (PID)/Tubo-ovarian abscess	Ovarian torsion	Pyelonephritis	Urinary tract infection (UTI)

Speaking Intelligently

When I'm asked to see a 28-year-old female who presents with a hx of lower abdominal pain associated with fever, I first try to separate GI and GYN causes. An appropriate menstrual and sexual hx are essential, as is a hx of GI and GU symptoms. I look for the prodrome of appendicitis. I obtain a quantitative β-hCG pregnancy test to r/o ectopic pregnancy, a U/A and CBC for starters; if tachycardia and hypotension are present, particularly in face of a missed period, I start IV fluids and seriously entertain the dx of ectopic pregnancy. Appendicitis is usually a clinical dx, but if unclear, pelvic ultrasonography or CT of the abdomen and pelvis would be helpful. When the dx is between appendicitis and a GYN condition, diagnostic laparoscopy may be of great benefit.

PATIENT CARE

Clinical Thinking

- Think of what surgical condition in the differential dx would lead to trouble quickly. In this instance it's ***ectopic pregnancy,*** which is a hemorrhagic condition. Keep this in mind as you sort the differential dx.

- As you proceed with the physical examination, keep in mind which entities are likely to present with peritoneal findings (tenderness, guarding, and rebound).

History

- Consider the nature, duration, and type of pain. Where did it begin and where is it now?
- ***Appendicitis*** has a typical prodrome beginning with vague periumbilical discomfort for 12 to 24 hours before inflammatory symptoms settle in the RLQ.
- Right sided ***ovarian torsion*** is usually of acute onset with RLQ pain noted first.
- Menstrual hx is vital to the dx of ***ectopic pregnancy***. Late or missed period is common, but patients are not always sure of this.
- Sexual hx is key to suspecting ***PID*** and ***tubo-ovarian abscess***, including hx of vaginal discharge and previous hx of PID.
- ***Pyelonephritis***—look for associated dysuria and urinary frequency and hx of previous UTIs. "Colicky pain" and the presence of hematuria are characteristic of ***ureteral colic***.
- Patients presenting with ***Crohn's disease*** (ileocolitis) will usually have a previous protracted hx of intermittent abdominal pain and diarrhea.
- ***Gastroenteritis*** is commonly associated with diarrhea in the absence of peritoneal findings.

Physical Examination

- VS: Fever suggests an inflammatory process. Hypotension can be associated with dehydration, sepsis, or hypovolemia secondary to a bleeding ectopic pregnancy.
- Observation: patients with colicky pain can't find a position of comfort, whereas patients with peritoneal findings prefer to lie still.
- Peritoneal findings (tenderness, guarding, rebound) are more likely in ***appendicitis, ectopic pregnancy, PID, tubo-ovarian abscess,*** and ***torsion;*** not present in ***gastroenteritis***. CVA tenderness may be prominent in ***pyelonephritis*** or ***renal colic.***
- Decreased bowel sounds are more frequently associated with a GI inflammatory process than a GU process. More diffuse lower abdominal tenderness may suggest ***perforated appendicitis, PID, tubo-ovarian abscess,*** or blood from an ***ectopic pregnancy***.
- Pelvic examination must be included. Cervical motion tenderness will indicate involvement of pelvic organs. A mass or adnexal fullness may be appreciated. "Chandelier sign" (exquisite tenderness on cervical motion) may suggest ***PID***.

Tests for Consideration

- **CBC:** leukocytosis suggests inflammatory process. **$35**
- **β-hCG:** essential in all patients to exclude pregnancy. **$135**
- **Urinalysis:** for pyelonephritis, nephrolithiasis, UTI. **$38**

- **Laparoscopy:** as therapeutic intervention or as diagnostic tool, particularly if dx of appendicitis vs. pelvic disorder can't be otherwise defined. **$1,200**

IMAGING CONSIDERATIONS

➔**KUB:** Simple abdominal x-ray showing kidneys, ureters, and bladder on one film. Search for appendicolith in RLQ as well as for kidney and gallstones. **$400**

➔**Pelvic ultrasonography:** Usually performed through a full urinary bladder although transvaginal sonography is faster. Sonography is particularly useful if GYN disorder is a key consideration. Sonography for appendicitis is practical in the pediatric age group but has many false negatives. **$560**

➔**CT of abdomen and pelvis with oral/IV contrast:** Imaging modality of choice for appendicitis. Requires oral contrast which may take a significant amount of time to opacify the terminal ileum and cecum (an hour or more) due to slow peristalsis in ill patient. Very valuable for preoperative planning when appendix is in unsuspected location (retrocecal) or appendicitis is complicated by abscess/rupture. **$950**

Clinical Entities — Medical Knowledge

Appendicitis

Pφ *Appendicitis* is an inflammation of the appendix usually brought about by occlusion of the appendiceal lumen by a fecalith. Initially, the distended appendix produces vague abdominal pain sensed as a vague "stomach ache" in the periumbilical region.

TP As the serosa of the appendix becomes inflamed, the patient becomes aware that the pain has migrated to the RLQ. Usually associated with a mild leukocytosis.

Dx If the prodromal pattern and the subsequent physical findings of RLQ peritoneal irritation are characteristic, a clinical dx of appendicitis can be made. A markedly elevated WBC, fever, or wider distribution of peritoneal findings may suggest perforated appendicitis. When the diagnosis is unclear, CT is the most helpful test.

Tx Laparoscopic or open appendectomy. **See Sabiston 49, Becker 15.**

Pelvic Inflammatory Disease

Pφ After acquisition of a vaginal or cervical infection, the infection then ascends into the upper genital tract, leading to salpingitis. The organisms most commonly associated are *Neisseria gonorrhoeae* and *Chlamydia trachomatis,* but the infection may be polymicrobial in nature, including mixed anaerobic and aerobic bacteria.

TP Personal sexual hx is key; physical examination is usually characterized by tenderness in the lower abdomen and tenderness of the adnexae (usually noted on movement of the cervix or uterus), associated fever, and vaginal discharge.

Dx Dx is based on clinical picture and vaginal cultures. Pelvic ultrasonography or CT should differentiate from appendicitis. Laparoscopy may be required for dx and may be helpful for pelvic lavage.

Tx Tx for acute pelvic inflammatory disease can include cefoxitin, ampicillin, tetracycline, doxycycline, clindamycin, or metronidazole. Tx is with oral or IV antibiotics, depending on severity. A patient's likelihood of compliance may be an issue, and may guide how you proceed with therapy. **See Sabiston 75, Becker 14.**

Tubo-ovarian Abscess

Pφ ***Tubo-ovarian abscess*** is essentially a later stage PID characterized by more complex adnexal masses with thickened walls and central fluid.

TP Presentation is similar to that of PID but often on the background of previous clinical episodes.

Dx The typical ultrasonographic appearance of a tubo-ovarian abscess is a multilocular, cystic, complex adnexal mass, often with debris and thick septations.

Tx When a patient is unresponsive to a triple antibiotic regimen of IV antibiotics (e.g., ampicillin, clindamycin, and flagyl), the condition requires surgical intervention which may include total abdominal hysterectomy and bilateral salpingo-oophorectomy (TAH-BSO) for definitive therapy. **See Sabiston 75.**

Ectopic Pregnancy

Pφ ***Ectopic pregnancy***, a pregnancy in which the fertilized ovum implants on any tissue other than the endometrial lining of the uterus (95% occur in the fallopian tube), is a potentially hemorrhagic and life-threatening condition and must be r/o first when seeing a young woman with lower abdominal pain. Risk for an ectopic pregnancy is increased 6 to 10 times in a woman with a hx of PID.

TP A hx of missed period is characteristic. β-hCG is important for all women with child-bearing potential. The clinical impression is the most important factor in making a timely dx of ectopic pregnancy.

Dx Vaginal probe ultrasonography is best for imaging the uterus. A normal gestational sac can be seen by the time the β-hCG level reaches 2,000 mIU/mL. By 5.5 to 6 weeks of pregnancy (1.5–2 weeks after the missed period) intrauterine pregnancies should be seen by vaginal ultrasonography. The most common finding for ectopic pregnancy is a unilateral adnexal mass, some fluid in the pelvis, and no normal pregnancy structures in the uterus; however, 20% to 30% of ectopic pregnancies will have no abnormal ultrasonographic findings.

Tx In the face of significant hemorrhage, laparotomy is preferred as it can be carried out more rapidly. Otherwise, tx of ectopic pregnancy can be performed via laparoscopy and usually consists of salpingectomy (removal of the tube) or salpingotomy (opening of the tube and removal of the implant). In general, salpingectomy will be the procedure of choice if future fertility is of no concern, if the tube is ruptured, if there is significant anatomic distortion, or if there is overt hemorrhage. In many instances, if the patient is entirely stable, ectopic pregnancy is managed medically by administering methotrexate. **See Sabiston 75, Becker 14.**

Pyelonephritis

Pφ ***Pyelonephritis*** is an infection of the upper urinary tract most often caused by gram-negative organisms, most commonly *Escherichia coli, Klebsiella, Proteus mirabilis*. *Enterococcus* (gram-positive) is also common. *Pseudomonas aeruginosa* is often detected in hospital-acquired UTIs.

TP The patient usually presents with fever, back or flank pain, and dysuria and frequency.

Dx Dx should be recognized by pattern recognition of hx, physical examination, and U/A. CVA tenderness is usually present. Guarding and rebound may be present on the anterior abdominal wall, mimicking the diagnoses of cholecystitis or appendicitis. White cell casts may be present in the urine. Contrast-enhanced CT scans may be very sensitive for the detection of acute renal parenchymal inflammatory disease, but are not indicated in acute pyelonephritis because CT dx does not change management.

Tx Tx is appropriate antibiotic therapy.

Urinary Tract Infection

Pφ ***Pyelonephritis*** has been considered above. Lower tract infections such as cystitis may also present with lower abdominal pain.

TP Symptoms of dysuria and frequency and the absence of peritoneal signs should help distinguish UTIs from surgical conditions.

Dx As with pyelonephritis, U/A and urine culture and sensitivity (C & S) are the mainstays of dx.

Tx C & S defines appropriate antibiotic tx. **See Becker 10.**

Mesenteric Adenitis

Pφ ***Mesenteric adenitis*** of the ileocolic mesentery is most frequently caused by viral pathogens, but other infectious agents have been implicated, including *Yersinia enterocolitica, Helicobacter jejuni, Campylobacter jejuni,* and *Salmonella* or *Shigella* species. An association with streptococcal infections of the upper respiratory tract, particularly the pharynx, has been reported. Particularly in children, lymph node involvement may be a reactive process to a primary enteric pathogen.

Mesenteric adenitis is a self-limited condition characterized by fever, abdominal pain, nausea, and, occasionally, diarrhea.

TP Pain and tenderness are often centered in the RLQ, but they may be more diffuse than in appendicitis. The site of tenderness may shift when the patient's position changes, whereas the site of the tenderness tends to remain localized with appendicitis. Leukocytosis is common.

Dx The dx of mesenteric adenitis is one of exclusion. Ultrasonography of the RLQ with graded compression has been the mainstay of dx in children. Recently, many centers have adopted CT as a primary diagnostic modality.

Tx Management is nonoperative. **See Sabiston 43.**

Ureterolithiasis

Pφ ***Ureterolithiasis*** usually presents as intermittent "colicky" flank, back, or abdominal pain characterized by the patient's inability to find a comfortable position. The pain usually begins in the side or upper abdomen and travels down to the lower abdomen. It may radiate into the pubic region. In men the pain commonly radiates into the penis or testicles. Hematuria is often present.

TP CVA tenderness on the affected side is characteristic. Peritoneal findings should be absent; however, there is often anterior abdominal tenderness and possible rebound tenderness, which must be carefully interpreted.

Dx Urinalysis looking for hematuria is key (85% will have RBCs). The dx can be made by simple KUB, if a stone is radiopaque (60%–70%). Ultrasonography is good for detecting hydronephorosis. IVP or CT urography are more definitive tests.

Tx Retrograde pyelography may be indicated when there is a need for an endoscopic surgical procedure. While most smaller stones will pass spontaneously, extracorporeal shock wave lithotripsy is a highly effective tx. **See Sabiston 77, Becker 63**.

Ruptured Ovarian Cyst

Pφ ***Ovarian cysts*** are typically functional (not disease related) and disappear on their own.

TP During the days preceding ovulation, a follicle grows. If a follicle fails to rupture and release an egg, the fluid within the follicle may persist. Such functional cysts usually disappear within 60 days without tx and are relatively common. Functional ovarian cysts are not to be confused with other disease conditions involving ovarian cysts, specifically benign cysts of various types that must be treated to resolve. There are also true cystic ovarian tumors.

A cystic ***rupture*** usually presents as acute lower abdominal pain without any significant prodrome. Often there is a previous hx of ovarian cysts.

Dx Pelvic examination usually shows tenderness on cervical motion and anterior tenderness when the adnexa are put on stretch. Hx and physical examination should differentiate ovarian cysts from appendicitis and PID. A ruptured ovarian cyst can produce a massive hemoperitoneum with clinical symptoms and sonographic features that closely mimic ectopic pregnancy. Pelvic ultrasonography will often show cysts or cyst remnants. β-hCG is important to r/o ectopic pregnancy.

Tx Tx is excision by laparoscopy or laparotomy. **See Sabiston 75.**

Ovarian Torsion	
Pφ	***Ovarian torsion*** usually presents as acute RLQ pain without any significant prodrome.
TP	Often there is a previous hx of ovarian cysts. Pelvic examination usually shows tenderness on cervical motion and anterior tenderness when the adnexa are put on stretch.
Dx	Dx of this condition is difficult, and is generally clinical. Ultrasonography with Doppler flow is sometimes helpful.
Tx	Tx is by laparoscopy or laparotomy. In some instances the torsion may be surgically "untwisted" and the tube and ovary may be left in situ. In the face of obvious necrosis or diminished blood flow, the ovarian complex should be surgically removed. **See Sabiston 75.**

Crohn's Disease/Terminal Ileitis	
Pφ	***Crohn's disease*** is inflammatory bowel disease, which can present in adolescents and young adults.
TP	Crohn's disease frequently presents with episodes of abdominal pain and diarrhea. Though the typical patient usually presents with a more chronic, episodic hx, Crohn's ileitis should be kept in mind when approaching the patient with RLQ pain.
Dx	In patients not previously diagnosed, look for thickening of the distal ileum on CT.
Tx	By laparoscopy or by laparotomy, Crohn's of the distal ileum is characterized grossly by inflammation of the bowel and "creeping fat"—mesenteric fat creeping over the bowel. If the appendix is normal at laparotomy for suspected appendicitis, the distal ileum should be inspected to exclude inflammatory bowel disease. If the dx is Crohn's ileitis, the appendix should be removed if the base of the appendix is healthy (see also Case 6, Abdominal Pain and Diarrhea). **See Sabiston 48, 50; Becker 22.**

ZEBRA ZONE

a. **Meckel's diverticulum:** diverticulum located approximately 20 cm from ileocecal valve. Can become infected much like appendicitis. If appendectomy is performed, but the appendix is normal, the terminal ileum should be carefully examined to exclude both Crohn's and Meckel's. **See Sabiston 48, Becker 57.**

b. **Mittelschmerz:** pain associated with ovulation and follicular rupture. May present as lower abdominal pain. Generally correlates with time of ovulation.

c. **Cecal diverticulitis:** may present as appendicitis in an older population, but unlikely in a 28-year-old. **See Sabiston 50, Becker 21.**

d. ***Yersinia enterocolitica*:** most often occurs in young children, presenting as abdominal pain and diarrhea. May present with right side pain and can mimic appendicitis. **See Sabiston 43.**

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
Effect of computed tomography of the appendix on treatment of patients and use of hospital resources

Authors
Rao PM, Rhea JT, Novelline RA, Mostafavi AA, McCabe CJ

Reference
New England Journal of Medicine, January 15, 1998;338(3):141–146

Problem
Although CT is diagnostically accurate, the effect of routine CT of the appendix on the tx plan, outcome, and cost of patients with suspected appendicitis is unknown.

Intervention
100 consecutive patients suspected of having appendicitis clinically underwent CT barring contraindications.

Quality of evidence
Prospective, nonrandomized trial (100 patients).

Outcome/effect
Routine CT scan led to changes in tx plan in 59% of patients, and included prevention of unnecessary appendectomy (13%) and unnecessary hospitalization (18%). These changes resulted in an estimated savings of $47,281.

Historical significance/comments
This paper looks at both best patient care and systems-based practice by challenging the traditional view that appendicitis is a clinical dx and suggesting that routine appendiceal CT may improve patient care and reduce the use of hospital resources.

Interpersonal and Communication Skills

Acknowledging Fertility Issues
A 28-year-old female about to undergo an operation for appendicitis or a GYN disorder will have great concern, even if unspoken, about future fertility. Certainly, if the suspected dx is tubo-ovarian abscess, PID, or ovarian torsion, the issue of future fertility must be addressed directly and as part of the operative consent. However, even if the dx is appendicitis, the issue should still be addressed to reassure the anxious patient that future fertility is unlikely to be affected.

Professionalism

Commitment to Maintaining Appropriate Relations with Patients
Performing a pelvic examination on a patient with discomfort in a busy ED challenges our professionalism. Be respectful. Create as safe and as private an environment as possible. Particularly in a teaching setting, minimize the number of people in the room. Minimize patient exposure by proper draping. A female nurse or other health professional should be present. When anticipating multiple consultants, defer pelvic examination to the most experienced decision maker. During the physical examination, explain what you will be doing and what you are doing. Be compassionate and gentle.

Systems-Based Practice

Cost Drivers: Imaging Studies
Traditional teaching is that appendicitis is a clinical dx and that CT is expensive and usually unnecessary. From a systems standpoint, however, this teaching is challenged by the EBM article provided above, which suggests that although an expensive test for an individual patient, CT may have an overall cost-effective effect on system practice.

Chapter 12
Right Upper Quadrant Pain in a 44-Year-Old Female (Case 2)

Joseph F. Golob MD and Christopher P. Brandt MD

Editor's note: Given the overlap of Cases 2 and 3 (Chapters 12 and 13), we suggest reading them as a single unit.

Differential Diagnosis

Biliary colic	Cholangitis	Pancreatitis	Peptic ulcer disease
Acute cholecystitis	Hepatitis	Pyelonephritis	Pneumonia

Speaking Intelligently

When asked to see a 44-year-old female patient with RUQ pain, I try to keep my mind open to all causes of abdominal pain, although as a surgeon my initial focus is on the hepatobiliary system. A detailed hx and physical will quickly narrow my differential dx. With questions about the pain, and its duration and radiation, I always include a hx of alcohol intake (***hepatitis, pancreatitis***) and urinary tract symptoms (***pyelonephritis***). A hx of intermittent RUQ postprandial pain will lead me to suspect gallbladder disease, while a hx of jaundice, pale stools, and pruritis will lead to consideration of either a primary hepatic process or posthepatic biliary obstruction. A CBC, U/A, liver function tests, amylase, and lipase (***pancreatitis***) should be routinely considered. ***Liver function tests*** and their pattern (primarily elevated transaminases vs. elevated bili and alkaline phosphatase) will direct me further to a process of hepatic dysfunction or posthepatic obstruction. ***Ultrasonography of the RUQ*** will usually be my first choice for imaging. If the gallbladder is the problem, RUQ tenderness on physical examination including a positive Murphy's sign (mid-inspiratory arrest when palpating the RUQ) along with fever and leukocytosis will help me differentiate between ***biliary colic*** and acute ***cholecystitis*** and will help determine the appropriate timing for surgery.

PATIENT CARE

Clinical Thinking

- Keep in mind conditions that can result in clinical deterioration or potential progression to sepsis without appropriate tx. These would include ***acute cholecystitis, ascending cholangitis, pyelonephritis, and a perforated ulcer.***
- In a patient with jaundice, consider the possibility of a primary hepatic process, intrahepatic cholestasis, or obstruction of the biliary tree.
- Consider a right lung process: don't forget to think "above the diaphragm."

History

- As with all abdominal pain histories, focus on the location, character, duration, frequency, timing, and alleviating/aggravating factors. A hx of intermittent, postprandial, RUQ pain, radiating to the right subscapular regions is characteristic of ***biliary colic.*** Patients with ***acute cholecystitis*** may have had a hx of ***biliary colic***, but now present with progressive, unrelenting pain and may have fever. Patients with ***pancreatitis*** have more persistent pain that often is centered more toward the epigastrium with radiation toward the back. Pain related to ***pyelonephritis*** is sensed more in the flank, and you should ask about associated dysuria and urinary frequency.
- Jaundice or other symptoms of hyperbilirubinemia, such as pale stools, dark urine, or pruritis can be seen in ***hepatitis*** and ***cholangitis*** and are also present in patients with an obstruction of the common bile duct due to a stone (choledocholithiasis) or mass (periampullary neoplasm).
- A careful social hx is important. Risk factors for ***hepatitis*** should be elicited, including IV drug use, recent personal or sexual contacts, medications, transfusions, alcohol use, or food exposures. Hepatitis is often accompanied by other prodromal constitutional symptoms such as fatigue, malaise, nausea, anorexia, and fever.

Physical Examination

- VS: Fever suggests an inflammatory process. Tachycardia and hypotension suggest sepsis or acute hemorrhage.
- Observation: Begin by getting a general sense of whether the patient appears acutely ill. Look for scleral icterus and jaundice. Patients with colicky pain often cannot find a position of comfort, whereas those with peritonitis tend to lie still.
- Auscultation: Decreased bowel sounds are associated more with a GI inflammatory process than a GU process.
- Palpation: A sharp, tender liver edge suggests ***hepatitis*** or hepatic congestion. Local peritoneal signs are common with ***acute cholecystitis***, as is a Murphy's sign. Patients with ***biliary colic*** generally have minimal to no tenderness on physical examination. Tenderness associated with jaundice and fever is indicative of

cholangitis, while costovertebral angle (CVA) tenderness is prominent in ***pyelonephritis***. A tender and palpable gallbladder is consistent with ***acute cholecystitis***, whereas a *non*-tender, palpable gallbladder associated with jaundice may suggest bile duct obstruction due to pancreatic cancer (Courvoisier's gallbladder). A pelvic examination is indicated in younger women to exclude pelvic inflammatory disease (PID) with associated secondary perihepatic inflammation (Fitz-Hugh-Curtis syndrome).

Tests for Consideration

- **CBC:** leukocytosis suggests inflammatory process. $35
- **LFTs (AST, ALT, alkaline phosphatase, total/direct bilirubin):** essential to dx of hepatitis, obstructive vs. nonobstructive jaundice. $75
- **Amylase and lipase:** to r/o acute pancreatitis. $45
- **Coagulation profile:** INR is an indicator of liver synthetic function $75
- **Hepatitis panel:** if suspicion for hepatitis based on hx, physical examination, and LFTs. $80
- **β-hCG:** to exclude pregnancy. $135
- **U/A:** for pyelonephritis, nephrolithiasis. $38

IMAGING CONSIDERATIONS

➔**RUQ ultrasonography:** Best performed in the fasting state. Sonography is highly sensitive to gallstones, wall thickening, and pericholecystic fluid. Pain upon compression of the gallbladder during sonography, "sonographic Murphy's sign," is highly suggestive of acute cholecystitis. Intra- and extrahepatic biliary ducts can be evaluated for stones or dilatation. $225

➔**HIDA scan:** Nuclear medicine biliary scan evaluates hepatic uptake of an isotope and biliary excretion. Usually not performed in an emergency setting and may take several hours to complete. If the gallbladder is not visualized, the cystic duct is presumed to be obstructed. $425

➔**CT of abdomen/pelvis with oral/IV contrast:** Uncomplicated gallbladder disease is best evaluated by ultrasonography. However, abdominal CT is the imaging modality of choice to evaluate the myriad of differential diagnoses of RUQ pain. Oral and IV contrast are absolute necessities to evaluate the pancreas and upper GI tract. $800

➔**MRCP** or $1,200

➔**Endoscopic retrograde cholangiopancreatography (ERCP):** Imaging tools to get a "road map" of just the biliary tree. MRCP is a noninvasive MRI scan of the abdomen that recreates a 3D image of the biliary tree and is very sensitive for CBD stones. ERCP is invasive but has the advantage to possibly treat CBD stones via papillotomy or to stent neoplastic strictures. $2,300

Clinical Entities — Medical Knowledge

Biliary Colic

Pφ Obstruction of the cystic duct or common bile duct caused by calculi results in "biliary colic." As a stone blocks the outflow tract, and the gallbladder contracts against this obstruction, acute pain occurs.

TP Pain is often postprandial, as amino acids and fats in the duodenum stimulate CCK release and contraction of the gallbladder. The pain is located in the mid-epigastric to RUQ and is often described as constant with increasing intensity. The pain may radiate into the back or interscapular regions. This visceral pain is often short-lived and can last minutes to hours.

Dx The dx is usually made based on the hx and presence of gallstones on ultrasonography. If the ultrasound is normal, a HIDA scan with gallbladder ejection fraction can establish a dx of gallbladder dyskinesia and chronic cholecystitis. Biliary colic alone rarely produces laboratory abnormalities.

Tx Diet modification to low-fat foods may reduce the frequency of recurrent symptoms, but laparoscopic cholecystectomy is considered the tx of choice. **See Sabiston 54, Becker 17.**

Acute Cholecystitis

Pφ ***Acute cholecystitis*** is most commonly caused by impaction of a stone in the neck of the gallbladder or cystic duct, causing complete obstruction of the contracting gallbladder, and setting off an inflammatory reaction in the gallbladder wall. Bacteria commonly involved include *Escherichia coli* and *Klebsiella* species. ***Acalculous cholecystitis*** (cholecystitis in the absence of stones) occurs most commonly in critically ill patients, and may be related to a decrease in mesenteric blood flow and lack of gallbladder stimulation.

TP Patients whose initial symptoms resemble those of biliary colic (when the cystic duct becomes obstructed) may evolve into acute cholecystitis over several days. The pain usually becomes constant, often associated with fever.

Dx Dx is made clinically and confirmed by leukocytosis and a RUQ ultrasound showing gallstones, thickened gallbladder wall, pericholecystic fluid, and a sonographic Murphy's sign. HIDA scan may be utilized if there is still diagnostic uncertainty. Mild elevation in liver enzymes can be seen.

Tx Initial tx includes keeping the patient NPO, and on IV hydration and antibiotics. For most patients, cholecystectomy within 24 to 48 hours of dx is the preferred tx method. In critically ill patients where surgical intervention carries significant risk (e.g., a severely compromised cardiac patient), a cholecystostomy tube can be placed percutaneously to drain the gallbladder as a temporizing measure. **See Sabiston 54, Becker 17.**

Cholangitis

Pφ ***Acute ascending cholangitis*** is caused by obstruction of the common bile duct, resulting in an ascending bacterial infection that involves the liver parenchyma and quickly becomes systemic. Patients with cholangitis can become septic with multiorgan dysfunction very quickly. Therefore, a high index of clinical suspicion and rapid tx is critical.

TP Presentation is described by ***Charcot's triad*** which includes jaundice, RUQ abdominal pain, and fever. As the disease progresses to systemic sepsis, patients may display ***Reynold's pentad***, with the addition of hypotension and mental status changes.

Dx Dx is based on clinical presentation, leukocytosis, elevated liver function tests, and an ultrasound showing stones and obstruction.

Tx Initial tx includes aggressive hydration and IV antibiotics, and urgent decompression of the biliary tree must be considered. This can be done by ERCP with attempt to remove any obstructing stone and/or by stenting the common bile duct. Percutaneous transhepatic biliary drainage (PTBD) is another option. The mortality rate for these less invasive procedures may be less than surgical intervention in these critically ill patients. Once the acute infection is treated, definitive surgical tx of the underlying cause of obstruction is indicated. **See Sabiston 54.**

Acute Hepatitis [See Chapter 29, Jaundice (Case 18)]

Acute hepatitis is usually the result of a viral infection and must be considered in the differential dx of RUQ pain. There are multiple viruses that cause liver disease, the most common being hepatitis A, B, and C. Hepatitis A usually presents with jaundice, fever, RUQ pain, nausea, and vomiting. Hepatitis B and C can present in the same manner but are often indolent with long incubation periods. **See Sabiston 52, Becker 10.**

Pancreatitis [See Chapter 13, Epigastric Pain (Case 3)]

The two main causes of pancreatitis are gallstones (40%) and alcohol (30%); other causes include metabolic (hyperlipidemia, hypercalcemia, cystic fibrosis), antatomical (pancreatic divisum, duct strictures), iatrogenic (ERCP), drugs (e.g., thiazide diuretics, azathioprine, lasix, steroids), infectious, and idiopathic (15%). Pathophysiology relates to cause: ***gallstone pancreatitis*** is a result of an obstruction of the pancreatic duct by gallstones resulting in backup of pancreatic enzymes and tissue damage/necrosis of the pancreas; ***alcoholic pancreatitis*** relates to a direct toxic effect on the pancreatic parenchyma. **See Sabiston 55, Becker 24.**

Pancreatitis is considered in greater detail in Chapter 13, Epigastric Pain (Case 3). Particular attention should be paid to prediction of the severity of any individual's disease calculated by "Ranson's Criteria" presented in the Evidence-Based Medicine box in Chapter 13, Epigastric Pain.

Peptic Ulcer Disease

Pφ Mucosal disruption of gastric or duodenal mucosa typically as a consequence of *Helicobacter pylori,* NSAIDs, or excess acid.

TP Epigastric pain that can occur immediately postprandial (gastric ulcer) or pain relieved with eating (duodenal ulcer), but can include any of the complications of ulcer disease: GI bleeding, perforation, or gastric outlet obstruction.

Dx Confirmed by EGD or UGI examination. Dx of complications includes free air on CXR/KUB (perforation), hemoccult positive stool (bleeding), or gastric distention with nonbilious vomiting (gastric outlet obstruction). Active infection with *H. pylori* made by tissue biopsy including *Campylobacter*-like organism test (CLO-test) or urea breath test. Gastric ulcers should always be biopsied to exclude carcinoma. Confirmation of NSAID use can be supported by platelet aggregation studies or serum salicylate level.

Tx Depending on etiology and complications: treat *H. pylori* active infection with a 2-week course of PrevPak (complicated PUD should also be treated regardless of proven active infection). Additional medical therapy includes acid suppression [H_2 blocker or protein pump inhibitor (PPI)] or sucralfate, and elimination of alcohol and NSAIDs. Surgery is reserved for complications: perforation, bleeding, obstruction, intractability, and carcinoma. **See Sabiston 46, Becker 26.**

Pyelonephritis [See Chapter 11, Right Lower Quadrant Pain (Case 1)]

Remember that guarding and rebound may be present on the anterior abdominal wall, mimicking the diagnoses of cholecystitis.

Pneumonia

Pφ Acute bronchoalveolar infection, with or without underlying chronic pulmonary disease, results in pneumonia.

TP While RUQ pain can be part of the presentation of patients of acute pneumonia or pulmonary infarct, chest findings will usually make the dx. Typically in pneumonia, pulmonary symptoms including cough, difficulty breathing, and fever predominate.

Dx Dx is made by chest examination and usually confirmed by CXR.

Tx Tx depends on findings. Auscultatory findings include decreased breath sounds and friction rub. **See Sabiston 59.**

ZEBRA ZONE

a. **Fitz-Hugh-Curtis syndrome** right upper quadrant pain caused by an ascending pelvic infection (usually PID) leading to perihepatic inflammation. **See Sabiston 43.**

b. **Hepatic congestion**—secondary to right-sided heart failure. **See Sabiston 53, Becker 19.**

c. **Retrocecal appendicitis**—atypical anatomic location can result in RUQ pain. **See Sabiston 49, Becker 15.**

d. **Pneumonia**—can present as RUQ pain from diaphragmatic irritation.

e. **Colon perforation/inflammation**—ischemic colitis, diverticulitis, carcinoma. **See Sabiston 50.**

f. **Hepatic neoplasm**—hepatocellular carcinoma, metastatic tumors from other locations, benign tumors, and cysts (hemangiomas, cysts, adenomas, focal nodular hyperplasia). **See Sabiston 52, Becker 18.**

Practice-Based Learning and Improvement: Morbidity and Mortality Self-Assessment Form	
Complication	Bile leak noted POD #1
Type	Technical error; preventable
Surgery performed	Laparoscopic converted to open cholecystectomy
Patient's disease	Acute cholecystitis
Presentation	200 mL bile noted in Jackson-Pratt drain on POD #1
Intervention	ERCP with stent
Outcome	Resolution of leak and complete recovery. Stent removed by ERCP after 3 weeks.
Risk factors	Very inflamed junction of cystic duct and common duct due to acute cholecystitis, diabetic patient.
How were risks addressed?	Careful dissection of cystic and CBD junction, duct doubly ligated, and drain left in gallbladder bed.
What happened?	Bile leak (200 mL) noted from drain on POD #1; probably tie on cystic duct dislodged. ERCP performed and stent placed in CBD.
What could have been done differently?	Consider oversewing the cystic duct, or, if the duct was very inflamed, placing a T tube.
Would outcome have been different?	ERCPs, stent, and stent removal might not have been needed.

Interpersonal and Communication Skills

Informed Consent

Informed consent is a critical communication process that must occur between physician and patient prior to a specific medical intervention. This process is an ethical obligation as well as a legal requirement. Informed consent must contain the patient's dx (if known), the purpose of the proposed procedure, a description of the procedure, risks and benefits of the intervention, alternative tx with their risks and benefits, and finally the risks and benefits of no tx. The intent is for the patient to use this information to generate questions before deciding to proceed with the intervention. Exceptions to informed consent include lack of decision-making capacity (lack of competence), emergencies, and therapeutic privilege (the physician feels that disclosure of medical information would harm the patient or affect the informed consent process).

Informed consent for a laparoscopic cholecystectomy must include risks for infection, bleeding, common bile duct injury, bile leaks, intestinal injury, and liver injury. Without unduly alarming patients, you must make them understand that while severe complication may be infrequent, these complications may result in additional medical/surgical procedures and in death in rare instances.

Professionalism

Principle of Patient Autonomy

Competent patients have the right to decline a surgical operation that is advised. During the informed consent process, the physician must decide if a patient has the ability to understand the dx and tx options and if the patient can generate and defend a rational decision about his or her care. There are times when the patient may appear "incompetent" to make such a decision. *Competence* is a legal term for a patient's ability to make informed decisions about specific medical care. Strictly speaking, all patients are competent to make medical decisions unless they have been determined incompetent by a court of law. When a patient's competence is called into question, it can be a difficult process for the patient, physician, and patient's family. For example, patients on ventilators or those who have a previous psychiatric dx do not necessarily lack decision-making ability, but decisions that appear irrational should be questioned. When patient competence is indeed in question, it is advisable to obtain help from psychiatric consultants and other appropriate hospital resource personnel (e.g., hospital counsel).

Systems-Based Practice

Understanding Your Costs: Activity-Based Cost Accounting
You are sitting in the medical staff lounge and one of the surgeons is complaining that he can no longer afford to perform laparoscopic cholecystectomies for a certain insurance company because he doesn't receive what it costs to do the procedure. Surgeons may base financial decisions on a minimum of evidence. Activity-based cost accounting may serve to clarify direct and indirect costs associated with provision of service. In activity-based cost accounting, costs are assigned to the activities related to providing specific services. Direct costs are those associated with each office visit such as administrative costs of verifying insurance, communicating with referring physicians, and making the appointment. Indirect costs are those that occur throughout the year and need to be allocated by procedure (e.g., rent, utilities, office supplies). Identifying actual costs related to a procedure improves your understanding of cost and revenue drivers. This information will serve you well in negotiating with managed care organizations and analyzing changes in payment schedules. Your fluency with cost and revenue drivers allows you to review your system for cost effectiveness.

Chapter 13
Epigastric Pain in a 47-Year-Old Male (Case 3)

R. Matthew Walsh MD

Editor's Note: Given the overlap of Cases 2 and 3 (Chapters 12 and 13), we suggest reading them as a single unit.

Differential Diagnosis

Peptic ulcer disease (PUD)/gastritis	Esophageal reflux/esophagitis	Biliary colic/cholecystitis
Hepatitis	Pancreatitis	Pneumonitis
Myocardial ischemia		

Speaking Intelligently

When asked to see a patient with epigastric pain, I try to prioritize a wide-ranging differential dx that includes medical and surgical conditions, from life-threatening to easily treated conditions. Patients with this presentation highlight the value of a thorough hx, which alone can lead to a reasonable assessment of the etiology of the symptoms and guide a short algorithm for evaluation. I use the hx to try to distinguish between **GI** (PUD, gastritis, gastroesophageal reflux disease [GERD], esophagitis), **peri-intestinal** (biliary tract, pancreatitis, hepatitis), and **supra-diaphragmatic** (pneumonitis, cardiac) pathologies. Virtually all patients should have an EKG and troponin/cardiac enzymes, CXR, liver function tests, and amylase level. I order ultrasonography when the hx is suggestive of biliary symptoms, not to search for incidental gallstones. When the hx suggests esophageal or gastroduodenal disease and its complications, a diagnostic EGD is indicated.

PATIENT CARE

Clinical Thinking

Besides organizing your differential by organ system, try to prioritize by severity, even if uncommon. ***Acute myocardial infarction*** can have atypical presentations, especially in women. Other conditions that require prompt dx include ***acute pancreatitis***, and ***acute esophageal rupture*** (Boerhaave's syndrome).

History

Hx is valuable to distinguish among the following possibilities. In each instance, pay attention to prior symptoms, risk factors, and disease sequelae:

- ***Peptic ulcer disease/gastritis:*** typically persistent pain. Eating causes exacerbation of pain in gastric ulcers, but tends to alleviate pain in duodenal ulcers. Response to prior acid suppression is important as well as findings on prior endoscopy, if done. Consider symptoms of ulcer complications including melena, hematemesis, and early satiety. Weight loss and family hx of gastric cancer may suggest a malignant gastric ulcer. PUD risk factors include aspirin, NSAIDs, and ETOH.
- ***GERD/esophagitis:*** Important considerations include burning pain with radiation up the chest, response to antacids and acid suppression, exacerbation when supine, prior symptoms, and acid regurgitation. Consider complications of disease, including dysphagia to solids or liquids, bleeding, and weight loss.
- ***Biliary tract symptoms:*** Elicit any prior similar symptoms or food intolerance, even if previously mild. Radiation to back, right side, and

referred pain to the shoulder. Pain is constant typically for hours, and is not fleeting. It is usually postprandial, but delayed (awakened from sleep), and not during a meal. Often associated with nausea and vomiting. Symptoms of disease complications include jaundice and fever. Risk factors included family hx, obesity, and irritable bowel disease (IBD).
- ***Hepatitis:*** Typically has constant pain; may radiate to back, RUQ, or shoulder. Prior episodes of pain or jaundice. The onset of pain is not usually abrupt. Disease complications may include jaundice. Risk factors to elicit include IV drug use, blood transfusion, travel hx, sexual exposure, medications, and ETOH use.
- ***Pancreatitis:*** Pain is constant and can bore through to the back. Often associated nausea/vomiting. Prior symptoms of biliary colic may suggest biliary pancreatitis. Prior hx of pancreatitis important. Family hx of pancreatitis should be sought. Risk factors include ETOH use, medications, and major trauma.
- ***Pneumonitis:*** Prodrome symptoms of the common cold may be present. Rigors tend to be more frequent, fever present at the onset, and vomiting less common in pulmonary disease compared to abdominal pathology. The pain often has a thoracic component as well as abdominal. Risk factors include exposure to pneumonia contacts and underlying pulmonary disease.
- ***Myocardial ischemia:*** Epigastric pain as a manifestation of acute cardiac ischemia is not uncommon, and therefore must be considered seriously in addition to abdominal causes such as cholecystitis which can mimic each other. Review carefully prior symptoms, including initiating factors, such as exertion. The pain can radiate to the neck and left arm. Elicit important risk factors, including family hx, diabetes, hypertension, hypercholesterolemia, and known cardiac disease. Also consider other cardiac conditions such as acute cardiac failure with passive hepatic congestion, pericarditis, and endocarditis.

Physical Examination
Evidence of an inflammatory process should be sought, which may be indicated by fever and peritoneal irritation. Signs of hypovolemia can be present as a consequence of many processes. Specific findings on physical examination that may apply to specific processes include:
- ***Peptic ulcer disease/gastritis:*** Melena or occult positive stool on rectal examination. Tenderness may be present in epigastrium. Supraclavicular adenopathy with malignant gastric ulcer.
- ***GERD/esophagitis:*** Erythema may be present in the hypopharynx. Typically mild to absent abdominal tenderness.
- ***Cholecystitis:*** Tenderness in the RUQ; may also have palpable mass or jaundice.
- ***Hepatitis:*** Examine for hepatomegaly; often there is diffuse tenderness, including the lateral aspect, elicited by pressure on the lower intercostal spaces. Jaundice, including scleral icterus.

- ***Pancreatitis:*** Epigastric tenderness and fullness. Ecchymosis in the back (Grey Turner's sign) or at umbilicus (Cullen's sign) may occur several days after symptom onset.
- ***Pneumonitis:*** Unilateral chest findings including rhonchi, wheezing, decreased breath sounds, and percussion dullness. Lack of abdominal findings.
- ***Myocardial ischemia:*** Cardiac examination for pericardial rub, additional heart tones, along with irregular pulse. Examine for signs of failure, including jugular venous distention, hepatic congestion, and peripheral edema.

Tests for Consideration

- **Troponin/cardiac enzymes:** assess for acute myocardial ischemia **$145**
- **EKG:** assess for irregular rhythm and ischemia **$150**
- **Amylase/lipase:** for pancreatitis **$75**
- **LFTs:** for hepatitis and cholestasis **$85**
- **EGD:** evaluate for esophagitis/PUD/gastritis **$750**

IMAGING CONSIDERATIONS

➔**Obstruction series:** Erect CXR and two-view abdomen series to evaluate for pneumoperitoneum, bowel obstruction, or pulmonary process. **$125**

➔**RUQ ultrasonography:** Best performed in the fasting state. Particularly useful for hepatic or biliary processes but may have limited evaluation of pancreas due to overlying bowel gas. **$225**

➔**CT of abdomen/pelvis with oral/IV contrast:** Oral and IV contrast are absolute necessities to evaluate the pancreas and upper GI tract. Modality of choice when evaluating the pancreas and retroperitoneum. **$800**

Clinical Entities — Medical Knowledge

Peptic Ulcer Disease is discussed in Chapter 12, Right Upper Quadrant Pain (Case 2). **See Sabiston 46.**

Biliary Colic and ***Acute Cholecystitis*** are considered in Chapter 12, Right Upper Quadrant Pain (Case 2). **See Sabiston 54.**

Hepatitis is considered in Chapter 29, Jaundice (Case 18). **See Sabiston 54.**

Esophagitis/GERD

Pφ Reflux of acid and/or bile in the esophagus due to inappropriate relaxation of the lower esophageal sphincter and/or gastric or esophageal dysmotility.

TP Retrosternal/epigastric burning that can be associated with regurgitation, dysphagia, or non-GI manifestations such as chronic cough, asthma, and hoarseness/laryngitis. Symptoms are often postprandial while recumbent and respond promptly to antacids. Patients have a varying concept of "heartburn," which must be clarified by hx.

Dx Precipitating factors and response to topical therapy are suggestive. Endoscopic findings include esophagitis (biopsy for confirmation and exclude eosinophilia), Barrett's esophagus (biopsy for dysplasia), hiatal hernia, and stricture. Additional studies of diagnostic value include 24-hour pH monitoring and esophageal manometry.

Tx Includes lifestyle modifications: weight loss, cessation of tobacco/alcohol/caffeine, avoiding large late meals, and head of bed elevation. Medical therapy includes protein pump inhibitors, H_2 blockers, and antacids. Surgical therapy is generally reserved for patients with persistent symptoms and is guided by response to medical therapy, physiologic measures (e.g., manometry), and complications (e.g., strictures). The usual surgery is a fundic wrap such as a Nissen which is typically done laparoscopically. **See Sabiston 42, Becker 27.**

Pancreatitis

Pφ Acute inflammation of the pancreas occurs as a direct consequence of direct toxic damage (e.g., alcohol) or obstruction of pancreatic/biliary drainage (e.g., gallstone pancreatitis or pancreatic divisum). The precise mechanisms are poorly understood, as are the factors that determine the degree of cellular injury. The inflammatory process affects all tissues in the retroperitoneum, pancreatic and peripancreatic.

TP The degree of inflammation of the pancreas is wide ranging, from mild to pancreatic necrosis, and thus the presentation is equally variable. The pain of pancreatitis is typically abrupt and constant. Pain is usually epigastric, but can include back pain, referred phrenic pain, and nausea/vomiting. Amylase/lipase are usually elevated in serum. Ranson's criteria should be determined to assess severity (see Practice-Based Improvement: Evidence-

Based Medicine section below). CT with bolus IV contrast is useful in severe cases to determine the presence of pancreatic necrosis.

Tx Initial tx includes volume resuscitation to avoid hypovolemic shock due to systemic and retroperitoneal third spacing. NG tubes are used only for persistent vomiting. A short course of antibiotics may be appropriate for severe forms. Persistent biliary obstruction related to choledocolithiasis requires ERCP. The remainder of care is directed at treating complications (e.g., debridement of infected necrosis) and eliminating potential causes (e.g., cholecystectomy for gallstones). **See Sabiston 55, Becker 24.**

Myocardial Ischemia

Pφ Acute occlusion of a coronary artery results in acute myocardial ischemia.

TP The location of the pain is usually retrosternal and is acute in onset, with radiation to jaw and left arm. Atypical presentations are common and can include epigastric pain.

Dx Predisposing risk factors and lack of abdominal findings suggest a cardiac etiology. EKG and cardiac enzymes are usually diagnostic. Echocardiography can assist in visualizing akinetic segments, chamber dilation, ejection fraction, and pericardial fluid.

Tx Reperfusion is the key to therapy and highlights the need for prompt recognition. Therapy with thrombolytics and emergent revascularization by coronary angiography and stenting are appropriate in certain clinical situations. **See Sabiston 61, Becker 29.**

ZEBRA ZONE

a. **Dissecting thoracic aortic aneurysm:** can present with acute onset of epigastric pain, rigidity of the abdominal wall, and shock. It can mimic a perforated peptic ulcer; but typically there are associated chest symptoms, no free air on CXR, and a widened aortic arch. **See Sabiston 60, Becker 38.**

b. **Acute esophageal rupture (Boerhaave's syndrome):** Rupture of the esophagus can occur spontaneously with forceful retching and vomiting. The pain is epigastric and radiates to the thoracic spine. Findings of a left pleural effusion and mediastinal air should be sought on CXR. A contrast study or chest CT can confirm the dx. **See Sabiston 41, Becker 27.**

c. **Esophageal dysmotility disorders:** Abnormal motility of the esophagus can cause epigastric pain and dysphagia. These symptoms are common in esophageal spastic dysmotility and achalasia that is due to impaired relaxation of the lower esophageal sphincter. See Chapter 24, Dysphagia (Case 13). **See Sabiston 41, Becker 27.**

Practice-Based Learning and Improvement: Evidence-Based Medicine

Title
Prognostic signs and the role of operative management in acute pancreatitis

Authors
Ranson JHC, Rifkind KM, Roses DF, Fink SD, Eng K, Spencer FC

Reference
Surgery, Gynecology, and Obstetrics, 1974;139:69–81

Problem
This study was conducted to assess methods to identify reliable prognostic signs, as well as indicators of severe pancreatitis.

Intervention
None

Quality of evidence
Retrospective chart review

Findings
Measures that correlated with significant morbidity or mortality were identified in two time periods: *on admission* (age > 55, WBC > 16,000, blood glucose > 200, LDH > 350, AST > 250) and *at 48 hours* (Hct drop > 10%, BUN rise > 5, serum calcium < 8, arterial $pO_2 < 60$, base deficit > 4, fluid sequestration > 6 L).

In patients found to have fewer than three of these signs at either admission or at 48 hours, the mortality rate was 3%. Among those meeting three or more of these criteria, the mortality rate was 62%.

Historical significance/comments
This is a classic study performed in 1974. Ranson's criteria continue to be widely used and taught as a prognostic index for survival in acute pancreatitis.

Interpersonal and Communication Skills

Discussing Alcohol Abuse
The clinical conditions of hepatitis and pancreatitis are often self-induced by excessive use of alcohol. Why alcohol is toxic to the pancreas in some individuals, and to the liver in others, yet rarely to both organs simultaneously, is unknown. What is certain is that complete cessation of alcohol is required to prevent further episodes. Long-term survival after surgical therapy of chronic alcoholic pancreatitis is also determined principally on whether alcohol is resumed. Talking to patients about their suspected substance abuse is difficult for both patient and surgeon, particularly when it has created a medical crisis. Take care to be nonjudgmental, to express your concern for the patient's overall health, and to offer hope. Acknowledge that sustained sobriety is a markedly challenging goal to achieve and that success requires that multiple support strategies be in place. Go beyond dispensing medical advice and help your patient obtain access to social support services, which often involve the entire family.

Professionalism

Principle of Patient Welfare: Commitment to Maintaining Appropriate Relations with Patients
Alcoholism is a debilitating disease that has wide-ranging impact on the lives of those afflicted. Therefore, one must be sympathetic to the challenges patients face to maintain sobriety, and one should resist being judgmental when recurrent symptoms occur as a consequence of resumed alcoholism. Successful sobriety requires social and family support structures and the ability to maintain employment and medical insurance, while avoiding abuse of other drugs. It should not be surprising to learn that approximately 80% of patients who undergo a major surgery for chronic pancreatitis will resume drinking, which then leads to recurrent pain and ultimately shortened life expectancy. Re-engagement and continued attention to the patient's social support systems is critical to a patient's recovery.

Systems-Based Practice

Provider Operations and Coordination
Drug and alcohol tx programs require long-term social services and substantial utilization of medical resources. Many patients on the surgical service will require social support systems. Become familiar with your colleagues in your hospital's social services department and with the tx resources in your area so that you are equipped to meet patients' needs. When you identify a patient who requires out-patient and/or in-patient rehabilitation, go the extra mile to see that the patient is connected to the local resource that is best matched to his/her health-care needs, insurance coverage, and financial and logistical capabilities.

Chapter 14
Lower Left Quadrant Pain in a 67-Year-Old Male (Case 4)

Rebecca S. Evangelista MD

Differential Diagnosis

Diverticulitis	Ischemic colitis	Colon cancer
Hernia	Ureterolithiasis	Gastroenteritis

Speaking Intelligently

When I'm asked to see a 67-year-old male who presents with complaints of LLQ pain, first I try to separate infectious from noninfectious causes. I ask about onset of symptoms, bowel habits, previous hx of similar episodes, GI symptoms, and hx of previous colonoscopy. I ask specific questions to determine if the patient is clinically obstructed. During the physical examination I look for focal versus diffuse abdominal tenderness and any signs of masses or hernias. I obtain a U/A, Chem 7, and CBC for starters; if tachycardia and hypotension are present, particularly in the face of ***peritoneal***

signs, I bolus IV fluids and seriously entertain the dx of perforated diverticulitis. Noncomplicated diverticulitis is often the clinical dx in this scenario, but if unclear, an upright abdominal x-ray and CT of the abdomen and pelvis can be helpful. When the CT shows thickening of the bowel wall without evidence of diverticuli, dx of an enteritis versus ischemic colitis may be made by endoscopic evaluation of the mucosa.

PATIENT CARE

Clinical Thinking

- Keep in mind which surgical conditions in the differential dx would lead to trouble quickly. In this differential dx, perforation secondary to ***diverticulitis***, ***carcinoma,*** or ***ischemia*** would require urgent surgical intervention.
- As you proceed with the physical examination, keep in mind which entities are likely to present with peritoneal findings (tenderness, guarding, and rebound).

History

- Consider the nature, duration, and type of pain. Where did it begin and where is it now?
- ***Noncomplicated diverticulitis*** typically begins with vague LLQ discomfort and continues to worsen with time. ***Complicated diverticulitis (perforation, abscess, or obstruction)*** can present with a more acute onset of LLQ pain that may or may not have started as noncomplicated diverticulitis.
- ***Gastroenteritis*** is commonly associated with diarrhea in the absence of peritoneal findings. ***Ischemic colitis*** may present similarly to gastroenteritis except for the addition of bloody diarrhea, and is more common in patients with a hx of cardiovascular or peripheral vascular disease.
- ***Colon cancer*** is usually not an acute presentation, but can present with acute symptoms if it is associated with perforation or obstruction.
- ***Hernias*** causing LLQ pain may be inguinal, incisional, or, very rarely, Spigelian, and should present with an associated mass.
- ***Ureterolithiasis*** is usually associated with “colicky pain” that waxes and wanes, and the presence of hematuria.

Physical Examination

- VS: Fever suggests an inflammatory process. Hypotension and/or tachycardia can be associated with dehydration, hypovolemia, or sepsis secondary to perforated viscus or abscess.

- Observation: patients with colicky pain can't find a position of comfort, whereas patients with peritoneal findings prefer to lie still.
- Peritoneal findings (tenderness, guarding, rebound) are more likely in ***diverticulitis,*** perforated ***colon cancer,*** and ***hernias*** with incarceration and/or strangulation. Not present in ***gastroenteritis***, uncomplicated ***ischemic colitis,*** and ***ureterolithiasis***.
- Decreased bowel sounds are more frequently associated with a GI inflammatory process than a GU process. More diffuse lower abdominal tenderness suggests ***perforation***.
- Palpate for ***masses*** in the LLQ and in locations of potential hernias (left groin and previous incisions). A mass in the abdominal wall suggests an incarcerated hernia. An intra-abdominal mass suggests complicated diverticulitis or carcinoma.
- Rectal examination: evaluate for tenderness, mass or blood.

Tests for Consideration

- **CBC:** leukocytosis suggests an inflammatory process. **$35**
- **Chem 7:** look for acidosis and dehydration with elevated creatinine. **$29**
- **U/A:** for hematuria. **$38**
- **Sigmoidoscopy:** may help r/o ischemic colitis and distal colon cancer. **$175**

IMAGING CONSIDERATIONS

➔**Obstruction series:** Erect CXR and two-view abdomen series to evaluate for pneumoperitoneum, bowel obstruction, or pulmonary process. **$175**

➔**CT of abdomen/pelvis with oral/IV contrast:** Imaging modality of choice in the evaluation of diverticulitis. Oral and IV contrast are absolute necessities to evaluate the GI tract. In addition to increased sensitivity to perforation and free intraperitoneal air, complications of bowel perforation such as fistulae and abscess are readily shown. Other forms of colitis may show characteristic findings and the GU tract is well evaluated. **$950**

➔**Barium enema:** No longer used in the routine workup of diverticulitis. Gastrograffin enema may have a role in evaluating bowel fistulae or distal colonic obstruction. **$350**

Clinical Entities | **Medical Knowledge**

Diverticulitis

Pφ ***Diverticulitis*** is an inflammation of (usually) one diverticulum of the colon. These are false diverticuli where mucosa protrudes through the other layers of bowel wall at points of blood vessel entry.

TP Initially, the inflammation produces vague but focal abdominal pain in the LLQ. As the inflammation worsens, the pain becomes more acute and may produce peritoneal signs, especially with perforation or abscess.

Dx Usually associated with a mild to moderate leukocytosis. If there is isolated LLQ pain without peritoneal signs, a clinical dx of noncomplicated diverticulitis can be made. If peritoneal signs, markedly elevated WBC, or more diffuse pain are present, perforation and abscess must be r/o. An upright abdominal film will demonstrate "free air"; a CT will delineate an abscess.

Tx Noncomplicated (no perforation, no abscess) diverticulitis can usually be treated with bowel rest, IV fluids, and IV antibiotics. Free perforation requires resection of the perforated colon and end colostomy (Hartmann procedure). A discrete abscess can often be initially drained by a percutaneous approach, which allows for control of sepsis, formal bowel prep, and a subsequent, elective one-stage colonic resection. **See Sabiston 50; Becker 21, 25.**

Gastroenteritis

Gastroenteritis is usually a viral, sometimes bacterial, infection of the colonic mucosa that causes decreased absorption and/or secretion of water in the colon, resulting in diarrhea. It should be considered in any differential dx of abdominal pain.

The prominent symptom is usually diarrhea and the characteristic examination result is the *absence* of peritoneal findings. [For a more detailed discussion of enteritis presenting as abdominal pain and diarrhea, see Chapter 16, Abdominal Pain and Diarrhea (Case 6).]

Colon Cancer

Pφ ***Colon cancer*** is a malignant neoplasm that originates from the mucosa of the bowel wall. Cases may be sporadic, arising initially in an adenoma, or secondary to polyposis syndromes or hereditary nonpolyposis colorectal cancer, known as Lynch syndromes I and II.

TP Left-sided tumors often present with a gradual change in bowel movements (e.g., narrowing, constipation). They may also be asymptomatic or discovered through evaluation of anemia, by occult fecal blood, or noted on screening colonoscopy. Acute presentation is associated with obstruction or perforation resulting in abdominal pain and tenderness. With complete obstruction there will likely be distention, vomiting, and obstipation.

Dx Noncomplicated tumors are diagnosed by colonoscopy or barium enema. Obstruction is a clinical dx and can be confirmed by plain x-ray. If obstruction is suspected, contrast enema or CT should confirm the dx of a colonic mass.

Tx Surgical resection is the primary tx for colon cancer. When colon carcinoma presents as complete obstruction or perforation, urgent laparotomy with colon resection will require a Hartmann procedure (end colostomy with internal closure of the rectal stump) due to the inability to implement a mechanical bowel prep and the resulting dangers of primary anastomosis. **See Sabiston 50, Becker 21.**

Hernia

Pφ ***Hernias*** are defects in the abdominal wall fascia. These defects allow peritoneum and intra-abdominal contents to protrude through the defect with increased abdominal pressure. The major risk is bowel incarceration leading to potential obstruction or strangulation. The etiology may be congenital or iatrogenic, such as from a previous inguinal or abdominal incision.

TP Nausea, vomiting, and distention may be present if the bowel is obstructed.

Dx Dx is made clinically by the presence of a palpable mass, which may or may not be reducible, or by a palpable defect. If the hx is consistent with a hernia and there is no palpable mass or defect on physical examination (as may be the case in the obese patient), CT may be helpful.

Tx Tx for incarcerated hernia is immediate operative exploration with repair of the hernia and possible bowel resection as indicated. **See Sabiston 44, Becker 16.**

Ureterolithiasis

Ureterolithiasis is considered in Chapter 11, Right Lower Quadrant Pain (Case 1). Pain is "colicky," hematuria is *present* (85%), and peritoneal findings are *absent*. Dx is made by KUB or CT urography. **See Sabiston 77, Becker 63.**

Ischemic Colitis

Pφ Inflammation of the colon caused by a disruption of the blood supply, either by an acute embolic event, thrombotic event, or reduced cardiac output. Cardiovascular disease, atrial fibrillation, and vasculitis are problems that predispose the patient to develop ischemic colitis.

TP Patients typically have nonspecific symptoms of abdominal pain, nausea, vomiting and diarrhea, but the distinguishing sign is ***bloody diarrhea*** due to sloughing of the mucosa. Cardiovascular symptoms may also be present, as embolus or hypotension may be the cause of the colonic ischemia

Dx Dx can be aided by guaiac stool studies, CT, and sigmoidoscopy. If an embolic or thrombotic event is suspected, mesenteric arteriography may be indicated.

Tx Tx includes addressing the underlying cardiovascular problem and supportive care; however, progressive ischemia may require resection. **See Sabiston 50, Becker 25, 37.**

ZEBRA ZONE

a. Sigmoid Volvulus: a rotation of the sigmoid colon on its mesentery causing obstruction and rarely vascular compromise. (*The presentation is usually one of obstruction and diffuse abdominal pain rather than LLQ pain.*) Usually volvulus can be excluded by the initial plain x-ray of the abdomen. **See Sabiston 50, Becker 21.**

b. Retroperitoneal mass: tumors of the GU system or retroperitoneal sarcomas can occasionally present with LLQ pain. These masses rarely present as acute LLQ pain and will often be diagnosed by out-patient CT scan. **See Sabiston 43.**

c. Constipation: abdominal pain is a common complaint with constipation but almost never presents as an acute abdomen. Proper hx and plain x-ray will lead to dx. **See Sabiston 50, Becker 23.**

d. Irritable bowel syndrome: condition of the colon with symptoms including cramping, bloating, abdominal pain, and constipation or diarrhea. Patients usually have a previous hx of similar symptoms, and abdominal examination findings are benign.

Practice-Based Learning and Improvement: Morbidity and Mortality Self-Assessment Form	
Complication	Anastomotic leak
Type	Technical error; probably preventable
Surgery performed	Sigmoid colectomy
Patient's disease	65-year-old woman who had had two previous hospitalizations for diverticulitis treated with antibiotics
Presentation	Tachycardia, fever of 101 on POD #4; CXR showed a large amount of free air
Intervention	Re-exploration, resection of the anastomosis with end colostomy and mucous fistula creation
Outcome	The patient did well and was discharged 4 days after the second operation.
Risk factors	Patient had been on steroids for rheumatoid arthritis.
How were risks addressed?	Steroids could not be tapered.
What happened?	There may have been undue tension on the anastomosis. The splenic flexure was not fully mobilized in order to minimize dissection and incision size.
What could have been done differently?	Mobilizing the splenic flexure might have resulted in less tension on the anastomosis.
Would outcome have been different?	If there had been no leak, the patient would not have required a second operation or a colostomy, and her hospital stay would have been shorter.

Interpersonal Skills and Communication

Discussing Colostomy

A 67-year-old with acute complicated diverticulitis usually cannot be bowel-prepped for the resection that is required. In this situation, a primary bowel anastomosis cannot be performed due to a high risk for anastomotic leak postoperatively. The only option in this situation is to perform a bowel resection, close off the distal bowel, and use the cut end of the proximal bowel to create an end colostomy (Hartmann procedure). When talking to a patient in this situation, I explain the danger of a leak that could result from attempting a primary anastomosis. I also explain that in a vast majority of cases the colostomy is temporary and usually reversible in 3 to 4 months after recovery. Patients often know what a colostomy is by the phrase "wearing a bag," and they are usually comforted to know preoperatively that there are many supports in place (e.g., home nursing, support groups, Web site resources). Rarely, patients will refuse the operation if they understand that wearing a "bag" is necessary. If a patient does refuse the operation, I take the time required to explain gently that there is no other appropriate choice.

Professionalism

Commitment to Professional Responsibilities: Avoiding Paternalism

Talking with a patient the age of your parent or grandparent can occasionally lead to an overly gentle tone which could be perceived as condescension. Keep in mind that this older person, although perhaps not knowledgeable about the medical field, has significant life experience and may actually be quite sophisticated in other arenas. Be careful of using language at one extreme or the other: complex medical terms versus overly simplified terms. Ask yourself if you are acting and responding to this patient as you would a patient who is decades younger; if your answer is "no," try to understand how your language is different, and consider modifying your approach.

Systems-Based Practice

Provider Operations and Coordination

LLQ pain in a 67-year-old yields a differential dx of surgical and nonsurgical entities. This may result in both medical and surgical consultations to evaluate the patient and to determine the most appropriate service for the patient. Until proven otherwise, be willing to take the patient onto the surgical service to complete the workup until a need for surgical intervention is r/o. Patients presenting with abdominal pain should be admitted expediently, and "turf struggles" should not delay patient care. If new or preexisting medical issues complicate the picture, early consultations can be requested.

Chapter 15
Groin Mass in a 68-Year-Old Male (Case 5)

Ryan S. Hoffman MD and Jonathan Gefen MD

Differential Diagnosis

Inguinal hernia	Femoral hernia	Pseudoaneurysm	Lymphadenopathy	Abscess

Speaking Intelligently

When I see a patient with a groin mass, I start with a detailed hx that focuses on its onset, duration, and local symptoms, as well as any associated systemic symptoms. I look to see if the mass is tender, nonreducible, or pulsatile, and if there are any overlying skin changes. If nausea, vomiting, or abdominal pain are present, I obtain an obstruction series. If signs of strangulation are present, the patient should be prepared immediately for the OR. The dx of an incarcerated hernia is usually established by physical examination, but labs, abdominal films, and CT can be helpful in difficult cases.

PATIENT CARE

Clinical Thinking

- Consider the conditions in the differential dx that would lead to trouble quickly. An acutely incarcerated ***hernia*** is a surgical emergency because entrapped bowel can become ischemic very quickly.
- Do not attempt to reduce an incarcerated inguinal mass in the face of tenderness, peritonitis, or other suspicion that the mass is strangulated.
- An ***abscess*** requires immediate incision and drainage
- A ***pseudoaneurysm*** requires prompt intervention to prevent expansion and hemorrhage.

History

- Consider any previous hx leading up to the groin mass: previous hernia repair? femoral artery catheterization? How did the bulge begin and how does it feel now?
- ***Inguinal hernias*** are associated with a bulge and new onset of pain or discomfort with straining.

- ***Femoral hernias*** usually present in older females and often go unnoticed until incarceration or strangulation occurs.
- ***Lymphadenopathy*** may arise in the setting of infection or neoplasm; ask about fevers, rash, weight loss, or previous hx of neoplasm.

Physical Examination

- VS: Fever suggests an inflammatory process.
- Abdomen: A ***hernia*** that is tender and nonreducible is incarcerated. Strangulated bowel within the hernia can lead to local erythema or discoloration of the overlying skin, signs of peritonitis (rebound, guarding), or obstruction (distention, obstipation).
- Skin: Erythema and fluctuance with or without drainage is seen with an ***abscess.***
- Lymph nodes: ***Lymphadenopathy*** appears as a firm, nonreducible, and sometimes tender nodular subcutaneous mass. Lymphoma is usually nontender and may present with enlarged nodes in multiple areas, including the cervical or axillary regions. A number of neoplasms can metastasize to the inguinal nodes; examine the skin (melanoma) and anorectal and genital regions (squamous cell carcinoma).
- A pulsatile, firm mass is characteristic of a ***pseudoaneurysm.*** Look for hx of recent femoral puncture (as in a cardiac catheterization patient or an IV drug abuser).

Tests for Consideration

- **CBC:** leukocytosis suggests an infectious process. **$35**
- **Fine-needle aspiration:** may be useful in distinguishing neoplastic vs. reactive lymphadenopathy. May confirm purulence in an abscess. **$250**

IMAGING CONSIDERATIONS

➔**Obstruction series:** Erect CXR and two-view abdomen series to evaluate for pneumoperitoneum, bowel obstruction, or pulmonary process. **$225**

➔**Duplex ultrasonography of common femoral artery:** Color Doppler evaluation of the common femoral artery and vein is diagnostic for pseudoaneurysm. **$250**

➔**CT of abdomen/pelvis with oral/IV contrast:** Generally not necessary to evaluate the inguinal region. However, if results of the physical examination are not definitive, as in the obese patient, CT may be useful to show sites of bowel obstruction, hernia, or masses not readily apparent. **$800**

Clinical Entities — Medical Knowledge

Inguinal Hernia

Pφ A defect in the abdominal wall at the internal ring (indirect hernia) or Hasselbach's triangle (direct hernia). As the hernia enlarges, it may become nonreducible (incarcerated). Bowel that is present inside an incarcerated hernia may become obstructed or strangulated.

TP Most hernias present as a bulge in the inguinal region, sometimes accompanied by local discomfort. Initially, an acutely incarcerated hernia will produce persistent local pain. Nausea and vomiting suggest bowel obstruction; severe pain, tenderness, and overlying erythema suggest strangulation.

Dx The dx is almost always based on physical examination. An obstruction series or CT may be helpful to aid in the dx or to confirm obstruction if results of the physical examination are equivocal.

Tx Elective surgical repair is recommended for symptomatic hernias. For an acutely incarcerated hernia, manual reduction should be attempted if there are no signs of ischemia or obstruction. An elective repair should then be undertaken. If signs and symptoms of strangulation are present, emergent surgery is required. **See Sabiston 44, Becker 16.**

Femoral Hernia

Pφ A femoral hernia develops in the small space medial to the femoral vein in the femoral canal. It is more likely to strangulate than an inguinal hernia because of the small, unforgiving space through which it occurs.

TP Intermittent bulging in the femoral region is common; however, a patient may be unaware of its presence until the hernia becomes incarcerated.

Dx Dx is based on physical examination, which reveals a hernia inferior to the inguinal ligament.

Tx Femoral hernias are managed surgically in the same manner as inguinal hernias. **See Sabiston 44, Becker 16.**

Lymphadenopathy

Pφ Single or multiple lymph node enlargement may result from any local or systemic infection (e.g., cat-scratch fever) or inflammatory process that provokes a lymph node reaction. Lymphadenopathy in the groin may also be secondary to neoplasms, particularly lymphoma, melanoma of the lower extremities or lower trunk, and squamous neoplasia of the anorectum.

TP The patient may present with unexplained fevers, malaise, or weight loss, or with no associated symptoms whatsoever. Palpable adenopathy may be localized to a single lymph node basin or may be systemic.

Dx Fine-needle aspiration biopsy can be useful to distinguish reactive nodes from neoplasm. For a dx of lymphoma, open lymph node biopsy is necessary to assess nodal architecture.

Tx Tx depends on specific dx.

Femoral Pseudoaneurysm

Pφ Following trauma to the femoral artery, bleeding from the artery is contained in the periarterial tissues, resulting in a pulsatile mass that communicates with the arterial lumen. It most often follows iatrogenic injury, as in cardiac catheterization or prior vascular surgery.

TP The typical patient has a pulsatile mass in the groin after a recent catheterization or invasive procedure.

Dx Duplex ultrasonography is the imaging modality of choice and will confirm pulsatile flow that communicates with the arterial lumen through a narrow neck.

Tx Tx depends on the size of the aneurysmal neck. Neck sizes less than 5 mm may be amenable to ultrasound-guided injection of thrombin to thrombose the pseudoaneurysm. Very small pseudoaneurysms may clot without intervention. Larger pseudoaneurysms require surgery to close the hole in the artery. **See Sabiston 65, Becker 38.**

Abscess

Pφ	An abscess is a walled-off collection of pus.
TP	It presents as an erythematous, tender mass. Patients frequently have a hx of previous abscesses or diabetes mellitus.
Dx	Dx is made by clinical examination. Needle aspiration can confirm purulence in equivocal cases. Ultrasonography will show fluid inside the abscess cavity.
Tx	Tx is by incision and drainage.

ZEBRA ZONE

a. A **varicocele** is an engorgement of the venous plexus of the scrotum or inguinal canal. It may lead to infertility and may be either surgically repaired or watched conservatively. **See Sabiston 77.**

b. An **undescended testicle** may present as a mass in the upper scrotum or groin. It can be treated with elective surgery to lower the testis into the scrotum. **See Sabiston 71, Becker 57.**

c. A **psoas abscess** may extend into the inguinal region. It requires surgical or percutaneous drainage.

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
Open mesh versus laparoscopic mesh repair of inguinal hernia.

Authors
Neumayer L, Giobbie-Hurder A, Jonasson O, Fitzgibbons R, Dunlop D, Gibbs J, Reda D, Henderson W

Reference
New England Journal of Medicine, April 29, 2004;350(18):1819–1827

Problem
Repair of inguinal hernias in men is a common surgical procedure, but the most effective surgical technique is unknown.

Intervention
Men with inguinal hernias at 14 Veterans Affairs medical centers were randomly assigned to either open mesh or laparoscopic mesh repair.

Quality of evidence
Prospective randomized trial of 2,164 male patients

Outcome/effect

Although the laparoscopic surgery group had less pain and returned to normal activities earlier than the open surgery group, recurrence was more common after laparoscopic repair (10.1% vs. 4.0%). This difference in recurrence rate disappeared with experienced surgeons (>250 laparoscopic hernia repairs) and in patients with recurrent hernias. In addition, the overall complication rate was slightly higher in the laparoscopic surgery group than in the open surgery group (39.0% vs. 33.4%).

Historical significance/comments

This is the first large, randomized study to directly compare the open and laparoscopic techniques for inguinal hernia repair. It suggests that the laparoscopic repair is best reserved for recurrent hernias, and possibly bilateral hernias.

Interpersonal and Communication Skills

Empathy: Understanding the Patient's Perspective

A groin mass that is suspicious for lymphoma or malignancy often requires biopsy to establish the dx. While this is strictly an elective procedure, any delay can cause extreme anxiety for the patient anticipating such a dx. When discussing the situation and scheduling the procedure, remember that, while there is little urgency from a surgical perspective, there is tremendous urgency and emotional distress from the patient's perspective. Voice your understanding of the patient's concerns to legitimize his or her feelings.

Professionalism

Commitment to Honesty with Patients

You diagnose an uncomplicated hernia and schedule an elective repair. The patient asks about performing a laparoscopic repair, but you are skilled only in open repairs. How do you respond?

It is important to disclose, during your discussion about tx options, that you perform only open repairs. Explain in detail the advantages and disadvantages of both techniques. Laparoscopic repairs are most advantageous for recurrent or bilateral hernias, but are still effective for most inguinal hernias. Laparoscopic repairs are associated with slightly less postoperative pain and a slightly shorter recovery time but with a higher risk for recurrence. Open repairs are the procedure of choice for very large or incarcerated hernias, and can be done with minimal risk for injury to major structures such as the bladder, bowel, or iliac vessels. They also can be safely performed under local anesthesia and sedation, rather than general anesthesia, which is required for laparoscopy. In most cases, either the open or laparoscopic approach would be acceptable. Patients appreciate candor and should be advised of all appropriate options.

Systems-Based Practice

Process Improvement
A patient has been referred to you for evaluation of an inguinal hernia he noted 5 weeks ago. It is not incarcerated, but “keeps on popping out” and is quite uncomfortable.

The patient expresses his frustration at the “process.” He arrives to the consultation angry that it took him several weeks to get an appointment with his primary care physician just to obtain the referral necessary to see you.

Why has health care escaped the “service revolution”? You can order a computer online tonight and have it at your house tomorrow morning. In order to do that, a commitment to service and process re-engineering needed to happen.

Popular business models are beginning to be used to re-engineer the health-care system. ***Six Sigma***, a business model of process improvement, consists of specific steps—”define, measure, analyze, improve, and control”—that can be applied to health-care process improvement. In the case of our angry patient, one could define the problem, measure the delay, devise a better referral plan, and then control to see that it is effective and satisfies customers/patients.

Chapter 16
Abdominal Pain and Diarrhea in a 43-Year-Old Female (Case 6)

Roy Phitayakorn MD, MHPE, Brett C. Gilbert DO, and Christopher P. Brandt MD

Differential Diagnosis

Appendicitis	Infectious colitis *Salmonella* *Shigella* Cytomegalovirus (CMV; HIV)	Antibiotic-associated diarrhea	Inflammatory bowel disease (IBD): Crohn’s disease
Viral gastroenteritis	Food poisoning	Irritable bowel syndrome (IBS)	IBD: ulcerative colitis

Speaking Intelligently

When I'm asked to see a 43-year-old female who presents with a hx of abdominal pain and diarrhea, I like to separate surgical and nonsurgical causes. My hx starts with questions about the abdominal pain including: onset, character, radiation, and what makes it better or worse. I ask about stool frequency and characteristics (bloody, watery, loose, etc.), hx of recent illnesses, use of antibiotics, sick contacts, travel hx, previous problems with bowel habits (constipation, diarrhea, or both), possible exposure to HIV, or family hx of Crohn's disease or ulcerative colitis. In the hospitalized patient, I keep **Clostridium difficile *colitis*** (antibiotic-associated colitis) high on my list. Though diarrhea is neither copious nor prominent in the presentation of ***appendicitis***, I always keep appendicitis in my differential dx.

If tachycardia and hypotension are present in a patient with severe diarrhea, I start early to treat with IV fluids to correct dehydration and electrolyte disturbances.

Imaging studies are often unnecessary in the initial workup of diarrhea, but when I encounter signs of distention or peritoneal findings that could suggest complications of **C. difficile *colitis*** or ***IBD*** (megacolon, perforation), I obtain a CT of the abdomen and pelvis.

PATIENT CARE

Clinical Thinking

Though diarrhea is not usually associated with ***surgical*** conditions, I keep in mind the following:

- Diarrhea associated with ***appendicitis*** is usually related to direct irritation of the lower colon or rectum by the inflamed appendix.
- Diarrhea associated with ***ischemic colitis*** is bloody, but the dx is more likely in an older age group.
- **IBD** (***Crohn's*** or ***ulcerative colitis***) typically presents with a more prolonged hx of GI symptoms.

History

- Consider the nature, duration, type of pain, and stool characteristics.
- ***Gastroenteritis*** usually presents with a hx of nausea/vomiting in addition to the diarrhea, often with recent onset and associated viral illness or sick contacts at home, and absence of peritoneal signs.
- ***Infectious colitis*** may have a hx of recent illness, ***bloody*** diarrhea, employment at a daycare center or as a food handler, recent antibiotic use, swimming in or drinking unsafe water, oral to anal sexual contact, or a visit to a foreign country or petting zoo.

Antibiotic-associated diarrhea, including **C. difficile *colitis,*** has an identifiable antecedent hx of antibiotic use.

- With ***food poisoning***, there is usually a hx of consuming unpasteurized dairy products, raw or undercooked meat or fish, or spoiled mayonnaise or other egg-related products.
- A hx of self-limiting episodes of constipation and/or diarrhea associated with psychological stress may be indicative of ***IBS***.

Physical Examination

- VS: Fever suggests an inflammatory or invasive process. Tachycardia and hypotension can be associated with dehydration and/or sepsis.
- Peritoneal findings (tenderness, guarding, rebound) are more likely in ***appendicitis, infectious colitis*** or complicated **C. difficile *colitis***. Not expected in ***gastroenteritis, uncomplicated IBD***, or ***IBS***.
- Rectal examination may demonstrate occult or gross blood in stool.

Tests for Consideration

- **Basic metabolic panel:** to diagnose associated electrolyte abnormalities and assess degree of dehydration. **$68**
- **CBC with differential:** leukocytosis suggests an inflammatory process. **$53**
- **Fecal leukocytes:** if infectious diarrhea is high on differential. **$29**
- **Stool culture:** if fecal leukocytes are positive. **$63**
- **Ova and parasites:** if fecal leukocytes are positive. **$56**
- **Stool for *C. difficile* toxin:** if hx of recent antibiotic use. **$125**
- **Colonoscopy:** if patient needs a definite dx and other tests inconclusive **$850**

IMAGING CONSIDERATIONS

Note: Routine imaging may not be necessary in this patient.

➔**Obstruction series:** Erect CXR and two view abdomen series to evaluate for pneumoperitoneum, colonic distention, or pulmonary process. **$400**

➔**CT of abdomen/pelvis with oral/IV contrast:** May be helpful if patient has localized signs of peritonitis or hx or exam suggestive of appendicitis. Pseudomembranous colitis and IBD can have characteristic appearances on CT. **$950**

Clinical Entities — Medical Knowledge

Appendicitis

Appendicitis is covered in Chapter 11, Right Lower Quadrant Pain (Case 1). Associated diarrhea may relate to rectal or colonic irritation by the inflamed appendix or intra-abdominal fluid related to the inflammatory process.

Tx of appendicitis is an urgent appendectomy (laparoscopic or open).

Infectious Colitis

Pφ ***Infectious colitis*** is caused by infection with various pathogenic bacteria, viruses, or protozoa, including: *Salmonella, Shigella, Campylobacter,* enterohemorrhagic *Escherichia coli*, *C. difficile*, *Rotavirus, Isospora, Cyclospora,* adenovirus, Norwalk-agent, and *Entamoeba histolytica*. These pathogens either directly invade or adhere to colonocytes and interfere with normal absorption and secretion.

TP Patients typically present with diarrhea of various durations and may have associated symptoms of dehydration, including postural light-headedness and low urine output. There may also be a hx of pathogen exposure.

Dx Dx is based on hx, clinical examination, and presence of fecal leukocytes. Patients with a recent hx of antibiotic use should also have a stool test for *C. difficile* toxin. Fever, bloody diarrhea, or hypotension may warrant a more extensive workup including stool cultures and stool sent for ova and parasites. Specifically request tests for enterohemorrhagic *E. coli* when it is high on the list of differential dx.

Tx Tx includes oral and/or IV hydration since dehydration is usually the most acute and life-threatening issue. Due to the development of antibiotic-resistant pathogens, empiric antibiotic tx should be limited to patients who have febrile illness or are definitively established to have shigellosis or *Campylobacter* infection. Tx of enterohemorrhagic *E. coli* with antibiotics is currently very controversial and most authorities would recommend supportive nonantibiotic tx only.

Antibiotic-Associated Diarrhea

Pφ Antibiotics can disrupt the normal GI tract flora and lead to a secretory diarrhea from incomplete absorption of simple starches. This diarrhea typically resolves on a low-starch diet. However, *C. difficile,* which is a pathogenic bacterium, can colonize the human GI tract after the normal gut flora have been altered by antibiotic therapy and release two toxins, Toxin A and Toxin B, that bind to intestinal cell receptors and lead to secretory diarrhea and inflammation. If a *C. difficile* infection remains undetected or the patient is immunocompromised, *C. difficile* can develop into pseudomembranous colitis with yellowish-white plaques approximately 1 cm in diameter scattered throughout the colon or rectum. A small minority of patients progress to fulminant colitis.

TP The inflammation caused by *C. difficile* is typically associated with abdominal pain, fever, and an elevated white blood cell count. Any antibiotic can lead to *C. difficile* colonization, but the ones historically associated with *C. difficile* infection include ampicillin, amoxicillin, clindamycin, and cephalosporins. Fluoroquinolones are now a common cause of a new endemic strain of *C. difficile*. Fulminant colitis presents with abdominal pain, hypotension, fever, and a markedly elevated white blood cell count (>30,000)

Dx Dx is based on hx, clinical examination, and the presence of *C. difficile* toxin on ELISA-based stool tests. If the dx is in doubt, flexible sigmoidoscopy or colonoscopy allows direct examination of the colorectal mucosa for signs of colitis and pseudomembranes.

Tx The patient should discontinue the offending antibiotic if possible and then start 500 mg of metronidazole TID for 10 to 14 days. If the patient is pregnant or cannot take metronidazole, vancomycin 125 mg QID is an alternative therapy. Patients who have fulminant colitis with impending perforation may require subtotal colectomy. **See Sabiston 14.**

Food Poisoning

Pφ Patients ingest either massive amounts of pathogen or pathogen toxin. The resulting preformed or formed toxins prevent normal food absorption and increase stool water and mucous secretion.

TP Patients will often present with a hx of pathogen consumption, usually at an event (picnic, baseball game, restaurant, etc.), and may recall other people at the same event experiencing identical GI symptoms. Symptoms within 6 hours suggest ingestion of a preformed toxin of *Staphylococcus aureus* or *Bacillus cereus*. Symptoms that begin at 8 to 14 hours suggest infection with *Clostridium perfringens*.

Dx Dx is typically clinical, based on hx and lack of peritoneal signs.

Tx This illness is typically self-limiting and patients should be instructed to avoid medications that may slow colonic transit of pathogens out of the body and should be advised to stay well hydrated.

Viral Gastroenteritis

Pφ Gastroenteritis is usually virally mediated (Norwalk or Norwalk-related) and causes small histopathological lesions in the jejunum that result in transient malabsorption syndromes.

TP Usually associated with nausea/vomiting, but can present with diarrhea only. Malaise and low-grade fever may be present. Look for hx of a recent viral illness, sick contacts in the family (especially if there are children in daycare), and travel hx (especially cruise ships).

Dx Dx is clinical only, and gastroenteritis is typically a dx of exclusion.

Tx Symptomatic tx only, as this illness is self-limiting for most patients, with complete resolution of symptoms within 48 to 72 hours.

Infectious Colitis in the Immunocompromised Host

Pφ The pathogenesis is the same as for infectious colitis assuming adequate T-cell host defenses. If T-cell counts are low (CD4 < 50) one must also consider AIDS-related CMV GI disease, and *Mycobacterium avian* complex (MAC).

TP AIDS patients can present with acute or chronic diarrhea and mucosal hemorrhaging that may lead to intestinal perforation.

Dx These diagnoses are usually discovered via hx/physical examination and a comprehensive diagnostic workup that includes stool studies for bacteria, *C. difficile* toxin, ova and parasites, and modified acid-fast smear for *Cryptosporidium, Cyclospora* or *Isospora*. If MAC is suspected, the workup should also include blood cultures for acid-fast bacteria. Sigmoidoscopy or colonoscopy may also be helpful to obtain biopsy samples for CMV. Imaging tests are generally not useful in these patients.

Tx Tx may require empiric therapy with a quinolone and metronidazole until all diagnostic test results are back. For CMV, current tx includes induction therapy with ganciclovir or foscarnet for 3 to 6 weeks and consideration of maintenance therapy. **See Sabiston 46, 48.**

Irritable Bowel Syndrome

Pφ The pathogenesis of this syndrome is currently unknown, but is often associated with psychological stress.

TP Patients typically present with altered bowel habits, often alternating between constipation and diarrhea. The diarrhea is often described as mucus-filled with feelings of incomplete evacuation. The diarrhea typically occurs only during the day and does not wake the patient at night. Associated symptoms may include dysmenorrhea, dyspareunia, reactive airway disease, and fibromyalgia.

Dx By definition, results of all diagnostic tests, including CBC, thyroid function tests, and endoscopy, will be normal.

Tx Tx for IBS includes dietary modification and patient education. Other therapeutic considerations include antispasmodic agents, antidepressants, and serotonin receptor antagonists.

Inflammatory Bowel Disease: Crohn's Disease

Pφ Crohn's disease is an IBD of uncertain etiology which is characterized by transmural inflammation.

TP The typical patient usually presents with a chronic, episodic hx of abdominal pain and diarrhea, although it is possible that the patient will first present with abscess, frank perforation, or fistula. Patients may also present with extraintestinal manifestations, such as oral aphthous ulcers, perianal disease, arthritis, skin disease, or fat malabsorption.

Dx Dx is typically via clinical hx and colonoscopy. Radiological studies (abdominal CT or barium small bowel follow-through) may help define Crohn's strictures or lesions in the small bowel.

Tx Initial therapy for Crohn's disease usually begins with 5-aminosalicylic acid (5-ASA) drugs, but may progress to tx with antibiotics, corticosteroids, or immunosuppressive agents. Surgical tx in Crohn's disease is for complications of the disease: obstruction, perforation, significant fistulae, or intractability despite medical tx. **See Sabiston 48, 50; Becker 22.**

Inflammatory Bowel Disease: Ulcerative Colitis	
Pφ	Ulcerative colitis is an IBD typically limited to the colonic and rectal mucosa. Pathogenesis is unknown, but may be part of a continuum of IBD along with Crohn's disease.
TP	Patients usually present with a gradual onset of abdominal pain, and diarrhea is frequently bloody.
Dx	Dx is typically made through colonoscopy and pathologic findings on biopsy (crypt abscesses, chronic gland changes, etc.).
Tx	Tx of ulcerative colitis is initially medical. First-line agents include topical 5-ASA suppositories, enemas, or steroid foams. Oral steroids may be required. The ileoanal reservoir procedure (J-pouch) is a surgical tx option for chronic ulcerative colitis that allows removal of the entire colon and all rectal mucosa and reconstruction without a permanent ostomy. **See Sabiston 50, Becker 22.**

ZEBRA ZONE

a. **Cholera:** *Vibrio cholerae,* a gram-negative bacterium endemic in many developing countries in the world, secretes a toxin that causes persistent activation of adenylate cyclase and leads to increased chloride secretion and decreased sodium absorption, producing massive fluid and electrolyte loss. **See Sabiston 26.**

b. **Typhoid:** typically caused by *Salmonella typhi* via ingestion of contaminated water. Very rare in the United States, but common in the developing world. **See Sabiston 48.**

c. ***Yersinia enterocolitica:*** typically occurs in young children with occasional outbreaks in the United States. Patients present with abdominal pain and diarrhea that can mimic appendicitis. **See Sabiston 26.**

Practice-Based Learning and Improvement: Morbidity and Mortality Self-Assessment Form	
Complication	*C. difficile* colitis
Type	Associated condition; unpreventable
Surgery performed	Graham patch repair of duodenal ulcer

Patient's disease	60-year-old man with perforated duodenal ulcer
Presentation	Copious diarrhea on POD #5
Intervention	PO metronidazole
Outcome	Discharged home on PO metronidazole
Risk factors	Patient had been on IV antibiotics for 5 days due to perforated ulcer and contaminated abdomen.
How were risks addressed?	There is no preventive measure for avoiding *C. difficile* colitis when it results from indicated antibiotics. Due to his peritonitis following a perforated ulcer, antibiotics were justified.
What happened?	The patient developed copious diarrhea and low-grade fever on POD #5; results of *C. difficile* testing were positive.
What could have been done differently?	Judicious use of antibiotics (although in this case the patient required them). Careful hand washing by all health-care workers.
Would outcome have been different?	If he had not developed antibiotic-associated colitis, his hospital course would have been 3 days shorter and he would not have required oral antibiotics

Interpersonal and Communication Skills

Discussing HIV

One practitioner's suggestion for language related to the professionalism challenge of using appropriate language to ask about risk factors for HIV follows. "Appropriate" language includes using plain English and simple, lay words.

To help me try to find out what might be causing your problem, I need to ask you a few questions about your sexual history and possible exposure to viruses. These are things that we ask all of our patients with these symptoms.

- Are you presently sexually active?
- Have you had multiple partners?
- Do you think that you may have ever been exposed to the AIDS virus? Can you tell me a little more about why you think that?
- Have you ever had a blood transfusion or given yourself IV drugs?
- Do you always use condoms when you are having sex?

Professionalism

Commitment to Patient Confidentiality

Challenge: Asking about HIV exposure is an important skill for all medical students to learn during clerkships and for residents to polish during residency. It should be emphasized to the patient that these are routine questions and that patients have a right to refuse to answer any question that they do not feel comfortable answering. Patients should be reassured that their answers to these questions are generally confidential under state law and that the information will be used only to facilitate dx and tx, but physicians should be aware of exceptions to the general rule. Patients should be asked specifically about previous blood transfusions, IV drug use, unprotected sexual intercourse, and occupational exposure to HIV-contaminated fluids. If there is any concern that the patient may be HIV positive, a physician should obtain informed consent to conduct a confidential HIV test of the patient's blood.

Systems-Based Practice

Health-Care Information Technology: PDAs, CPOE, and EHRs

You have just seen your partner's patient in the ED with recurring abdominal pain and diarrhea. You know that she has been treated for this before, but when this patient arrives in the ED on a Saturday, her file is in a cabinet in your locked office miles away. Paper-based medical records increase costs (lab tests are unnecessarily repeated) and the chance for errors (patient status may impact available hx). A patient such as this one will likely require the careful tracking of multiple lab tests, a task that can be done on paper, but is much more easily done on computer.

This scenario emphasizes the enormous potential of information technology to impact the way in which we practice medicine. Envision the ideal situation where you access this patient's electronic health record (EHR) on your PDA, write in-patient orders wirelessly through the hospital's computerized physician order entry (CPOE) system, and wirelessly transmit out-patient prescriptions to the patient's drugstore. While for most of us this is still something of a distant vision, the widespread adoption of PDA-based software by physicians suggests that this transition may be quite welcomed by the medical community.

Chapter 17
"Free Air" in a 72-Year-Old Female (Case 7)

Karen J. Brasel MD, MPH

Differential Diagnosis

Perforated ulcer	Perforated diverticulitis	Perforated cancer
Perforated small bowel obstruction	Anastomotic breakdown	Perforated cecum

Speaking Intelligently

When I'm asked to see a 72-year-old woman with free air, my first thought is that the patient likely needs an operation, as the vast majority of conditions that cause free air require surgical correction. However, there are a few benign causes of free air, and a minority of patients with perforated ulcer or perforated diverticulitis can be treated nonoperatively. Therefore, my initial effort is concentrated on determining whether I need to prepare the patient for the OR. Many of these patients are extremely ill, with hypotension and tachycardia. After determining the need for operative exploration, I next determine whether the patient needs resuscitation and monitoring prior to the induction of anesthesia. Only after this has been done do I focus on trying to determine the exact cause of the free air.

PATIENT CARE

Clinical Thinking

- Try to elicit peritoneal findings (involuntary guarding and rebound). Peritoneal findings in a patient with free air mandate operative exploration.
- Mental status in the elderly can be a clue to the adequacy of perfusion and resuscitation.
- Medications may mask abdominal findings, and many elderly patients are often on multiple medications. Medications may also be causative: pay particular attention to narcotics, nonsteroidal anti-inflammatory drugs, and steroids.

- When in a consulting situation, check whether previous physicians may have given narcotics early on in the hospital course.
- Although many patients with abdominal pain frequently get fast-tracked to CT, the dx of peritonitis does not require sophisticated imaging. In fact, the oral contrast ingested and the delays in obtaining the CT often do more harm than good. A complete hx and physical examination, prompt resuscitation, and timely operative intervention will provide the best care for these patients.

History

- Consider the nature, duration, type of pain:
  - Where did it begin and where is it now?
  - Was the onset acute?
  - Did the nature of the pain change during its course?
- ***Perforated ulcer*** is often preceded by a hx of ulcer disease. Patients may describe a variable time of vague upper abdominal pain and then pinpoint (the exact time of perforation) when the pain became much more intense. They may also relate a hx of arthritis or other disease for which they take NSAIDs.
- ***Perforated diverticulitis*** may be preceded by a hx of diverticular disease.
- ***Perforated cancer*** may be suspected with a hx of change in bowel habits, melena, anemia, or recent obstructive symptoms.
- Patients with a ***perforated cecum*** usually have an antecedent hx consistent with a more distal large bowel obstruction or a prolonged and significant ileus.
- Patients with ***anastomotic breakdown*** will have an increase in pain 4 to 7 days postoperatively; often they have had low-grade temperature and continued ileus since operation.

Physical Examination

- VS: Perforated viscus is commonly accompanied by fever. Hypotension can be associated with fluid depletion or sepsis.
- Although the tenderness is likely to be diffuse, it may be greater in the epigastrium of patients with ***perforated ulcer***, in the RLQ in patients with ***perforated appendicitis and perforated cecum,*** or in the LLQ in patients with ***perforated diverticulitis***.
- Bowel sounds are decreased in most patients with peritonitis.

Tests for Consideration

- **CBC:** chronic anemia suggests either gastritis/ulcer disease or cancer. Expect a leukocytosis with perforated viscus. **$35**

IMAGING CONSIDERATIONS

→**Obstruction series:** Erect CXR and two-view abdomen series to evaluate for pneumoperitoneum, bowel obstruction, or pulmonary process. **Note:** *if physical examination demonstrates peritonitis, operation is required without further imaging*. ***CT*** is unnecessary in a patient with free air and peritonitis. **$300**

→**CT of abdomen/pelvis with water-soluble oral/IV contrast:** In selected cases of patients ***without peritonitis*** who are not on steroids, Gastrograffin (water soluble) oral contrast may be used. ***Avoid barium whenever perforation is suspected.*** **$900**

Clinical Entities — Medical Knowledge

Perforated Peptic Ulcer

Pφ Ulcer disease is due to acid hypersecretion or loss of the mucosal barrier function of the stomach. Infection with *Helicobacter pylori* often plays a role. Loss of mucosal barrier is seen in patients taking NSAIDs or steroids. Perforation occurs with continued acid exposure, and can occur in either the stomach or duodenum.

TP Patients typically can state exactly when the perforation occurred. The peritonitis is initially a chemical peritonitis, and patients lie still. They often relate that the drive to the hospital was exquisitely painful and that they "felt every bump."

Dx Upper abdominal pain, peritonitis, and free air on plain radiography are key diagnostic features. Posterior perforations may be more difficult to diagnose, and may present with back pain and air outlining the psoas shadow. RLQ pain occurs after several hours as the irritating gastric or duodenal contents spill down the right colic gutter.

Tx Tx includes fluid resuscitation and closure of the perforation. Acid reduction can be achieved with medication or surgery. **See Sabiston 46, Becker 26.**

Perforated Diverticulitis

Pφ ***Perforated diverticulitis*** begins with an occlusion of a colonic diverticulum by feces.

TP Ongoing obstruction results in perforation of the diverticulum, often with resulting abscess formation or dissemination of feces throughout the abdomen.

Dx The dx is based on antecedent hx of LLQ pain and cramping followed by generalized abdominal pain associated with free air. Often the dx is suspected but not certain until laparotomy. Diagnostic features include LLQ or lower midline tenderness with peritonitis.

Tx Tx includes broad-spectrum antibiotics and resection of the involved segment of intestine. An ostomy is often required as resection and re-anastomosis should not be performed in the presence of significant peritoneal soilage and the absence of an adequate bowel prep. **See Sabiston 50, Becker 25.**

Perforated Cecum

Pφ When the large bowel is obstructed distally or when there is a process that profoundly distends the cecum (e.g., ileus, Ogilvie's syndrome), the cecum will be the portion of the bowel most at risk for perforation. According to the Law of Laplace, the intraluminal pressure required to stretch the wall of a hollow tube is inversely proportional to its diameter. The largest diameter in the colon is the cecum; hence, the cecum requires the least amount of pressure to increase in size. As the wall tension of the cecum increases, ischemia with longitudinal splitting of the serosa and perforation can occur.

TP There is usually a hx of antecedent large bowel obstruction (a distal obstructing lesion) or a significant colonic ileus as in Ogilvie's syndrome.

Dx Cecal perforation, like other viscous perforations, presents with peritonitis and "free air." Specific dx of a perforated cecum may not be made until the time of laparotomy.

Tx Tx includes broad-spectrum IV antibiotics due to fecal peritonitis and resection of the cecum. The decision for ileostomy or primary re-anastomosis (ileocolostomy) depends on the degree of peritoneal soilage and the patient's overall status. **See Sabiston 50, Becker 14.**

Perforated Cancer

Pφ ***Perforated cancer*** occurs when cancer obstructs the colonic lumen, resulting in colonic obstruction and subsequent perforation.

TP The hx is variable depending on the site of perforation; it is most common in the descending and sigmoid colon. Often a hx of increasing constipation with decreasing stool caliber is present.

Dx The dx may not be made until the time of laparotomy. Chronic anemia due to occult blood loss may provide a preoperative clue.

Tx Tx includes broad-spectrum IV antibiotics due to fecal peritonitis and resection of the involved segment of intestine with the formation of an ostomy. A careful intraoperative assessment of the rest of the abdomen, particularly the rest of the colon and the liver, for metastatic disease is necessary. **See Sabiston 50, Becker 21.**

Perforated Small Bowel Obstruction

Pφ ***Perforated small bowel obstruction*** is most often due to adhesions that cause a complete obstruction with build-up of air and fluid, resulting in perforation.

TP The patient usually complains of nausea, vomiting, constipation or obstipation, and abdominal pain.

Dx Dx is made by an antecedent hx of obstruction, abdominal distention, a previous abdominal operation, and free air. An obstructive pattern may or may not be present on plain abdominal radiography.

Tx Tx is preoperative IV antibiotics and laparotomy with small bowel resection and anastomosis. **See Sabiston 48, Becker 25.**

Anastomotic Breakdown

Pφ ***Anastomotic breakdown*** is a breakdown of a sewn or stapled anastomosis anywhere in the GI tract. Causes include tension, poor blood supply, and poor technique.

TP The breakdown most often becomes evident 4 to 7 days after the operation, although the patient often has a low-grade fever and more pain than expected for a few days prior to the development of free air.

Dx	Dx is based on hx, physical examination, and radiographic imaging. As a certain amount of free air is expected after laparotomy, CT may be required to help identify anastomotic problems.
Tx	Tx includes broad-spectrum IV antibiotics and reoperation, which would likely include creation of an ostomy for fecal diversion. **See Sabiston 15.**

"Free Air" Not Associated with Viscus Perforation

Pφ (See the Zebra Zone.) Air can enter the peritoneal cavity from the chest by tracking along the mediastinum and retroperitoneum, and from the female genital tract via the fallopian tubes.

In general, however, "free air" should be considered to connote a perforated viscus until proven otherwise.

ZEBRA ZONE

a. **Perforated appendicitis:** Periappendiceal extraluminal air can be seen on CT, and "free air under the diaphragm" on upright CXR may be seen on rare occasions. **See Sabiston 48, Becker 15.**

b. **"Free air" not associated with viscus perforation:** Consider mechanical ventilation, pneumothorax, cardiopulmonary resuscitation, pelvic manipulation or insufflation, and benign pneumatosis intestinales. Free air can also persist for several days following laparoscopy or laparotomy. *The key is to demonstrate the absence of abdominal findings.* In the critically ill patient or the unresponsive patient on mechanical ventilation, CT may be necessary to exclude intra-abdominal pathology.

Practice-Based Learning and Improvement: Morbidity and Mortality Self-Assessment Form

Complication	Sepsis
Type	Delay in dx; preventable
Surgery performed	Sigmoid colectomy with end colostomy and Hartmann's pouch (Hartmann's procedure)

Patient's disease	83-year-old diabetic woman with perforated diverticulitis
Presentation	Increasing abdominal tenderness 8 hours after admission for diverticulitis
Intervention	Resection of perforated sigmoid colon with abdominal wash-out and wound left open
Outcome	Prolonged ICU course with sepsis, with eventual recovery and discharge to a nursing facility
Risk factors	Diverticulitis, age
How were risks addressed?	Patient was admitted to the hospital and placed on bowel rest and intravenous antibiotics.
What happened?	Increasing abdominal pain prompted the resident to order flat and upright abdominal x-rays at 8 PM, but the films were not checked until 7 AM the next day, when the radiologist called to report "free air under the diaphragm" not noted on previous films. Patient was taken to the OR at 9 AM and found to have a free perforation with diffuse fecal contamination of the peritoneal cavity.
What could have been done differently?	Check any test you order in a timely fashion!
Would outcome have been different?	A difficult and prolonged septic course might have been avoided had the patient been taken to the OR sooner.

Interpersonal and Communication Skills

Discussing "Exploratory" and Diagnostic Possibilities

A 72-year-old woman about to undergo exploration for free air is often truly undergoing "exploration" because the dx may not be known preoperatively. Many may refer to it as "having an exploratory." The possibilities range from benign, relatively uncomplicated procedures such as an appendectomy to life-threatening conditions that will result in an ostomy and/or an ongoing tx challenge such as cancer. Describing the risks and benefits and all of the potential procedures without adding to the patient's underlying fears is challenging, but all must be covered. Give the information in small chunks, watch for signs that the patient is following what you are saying, and check for understanding by asking questions such as "Is this making sense to you?" It is helpful to have taken a careful hx so the most likely dx can be discussed, along with others that are less likely. In this situation, presenting the diagnostic outcomes is a greater and more important part of the discussion than the risks for bleeding and specific complications.

Professionalism

Principle: Integrity, Self-preservation, Continuity of Care
A postoperative patient who develops a complication such as an anastomotic breakdown has an expectation that you will continue to care for him or her. This concept of "continuity of care" has often been interpreted as providing all care for all of your patients, which leads to physicians who do not take good care of themselves and suffer the consequences of burnout, a high divorce rate, and stress-related illnesses. Although continuity of care is important and you should expect to take care of your own complications, patients understand that you need to take care of yourself and your family. Patients and families understand the need to participate in important life events such as attending a child's graduation or a sister's wedding. Communicate well with your colleagues to ensure that the patient receives appropriate care, and explain to the patient what will happen and who will be taking care of them.

Systems-Based Practice

Reimbursement: Risk, Employer-Sponsored Health Insurance, and Managed Care
Health maintenance organizations (HMOs) and preferred provider organizations (PPOs) will generally require a member to seek out special providers. "Free air" is a bona fide emergency and most plans will cover members in whichever ED they land.

The original concept of health insurance was to spread the financial risk of illness across larger groups of people, so that individuals would not be financially ruined by unexpected illness. During World War II, labor was scarce due to the war effort, and employers were prevented from competing over employees by raising wages, through government-enforced wage freezes. As a result, employers sought to compete over employees by offering fringe benefits, and chief among these was health insurance. As a result, the United States ended up with a principally employer-sponsored health insurance system. By the 1970s, the cost of health insurance had increased to the point where employers felt it was hindering their ability to compete globally with firms in countries where they did not need to provide health-care coverage. As a result, employers put pressure on insurance companies to reduce costs, and the result was the rise of managed care.

Up until the advent of managed care, the people who controlled health-care costs (principally physicians and hospitals) did not bear any of the financial risk for their decisions: there was little incentive to keep costs down. One of the principal innovations of managed care was to align incentives, by passing some of the financial risk down to the providers. In its purest form, this resulted in *capitation payments*, where a hospital and physician network would receive fixed monthly payments for each "covered life" and then be responsible for providing all necessary care out of that pool of money.

While there were many different types of plans and complicated financial arrangements, most managed care plans today take the form of either an HMO or PPO. An HMO reduces costs by limiting coverage to providers and facilities within a network and by managing access to specialized care. This is done through the use of primary care physician "gatekeepers," from whom patients must get a referral before visiting a specialist. A PPO is similar to an HMO except that it generally has a less strict set of coverage policies regarding its network and referrals: patients often pay a very small amount or nothing to go to a provider within the network, and pay a higher amount (usually 15%–20%) to go to someone outside of the network. In addition, primary care physician referrals are typically not required to see specialists.

Chapter 18
Abdominal Pain and Distention in a 63-Year-Old Man (Case 8)

Marjie L. Persons MD, Adeline M. Deladisma MD, MPH, and John D. Mellinger MD

Differential Diagnosis

Small bowel obstruction (SBO)	Volvulus	Mesenteric ischemia	Ileus
Large bowel obstruction (LBO)	Ogilvie's syndrome	Ascites	Intestinal perforation

Speaking Intelligently

When presented with a 63-year-old man with abdominal pain and distention, I try to keep in mind which entities might possibly require urgent intervention.

I ask myself the following three questions:

1. Is the situation acute vs. nonacute?
2. Is there peritonitis on physical examination?
3. Does the patient appear "sick" [i.e., severe discomfort, abnormal VS (tachycardia, increased respiratory rate, hypotension, fever), peritoneal findings, and decreased mental status]?

If I have determined that the patient has peritonitis and is "sick," I will work quickly on resuscitation (IV fluids, O_2, Foley catheter) even as I obtain my hx; I will obtain an obstruction series which should put me on the right track regarding perforation (free air) or bowel obstruction. Depending on the findings, CT may be in order.

If, on the other hand, this is not a highly acute situation, I will proceed with the same orderly evaluation, but without the urgency indicated above.

Lastly, when encountering pain and/or distention in this age group, I always keep in mind the dx of ***mesenteric ischemia***, so as not to be fooled by a relatively benign physical examination, which is characteristic of mesenteric ischemia in its early phases.

PATIENT CARE

Clinical Thinking

- First r/o conditions that are life threatening and require urgent operative management, such as acute mesenteric ischemia or SBO with strangulation.
- Perform a ***focused abdominal examination*** looking for diffuse tenderness, guarding, and rebound tenderness, the hallmarks of diffuse peritonitis.
- Have a low threshold for admitting elderly patients with abdominal pain. They may have atypical presentations for life-threatening conditions, and their clinical picture is often complicated by medical comorbidities.
- Serial physical examinations can be an important diagnostic tool to assure that the patient is not clinically deteriorating and has not developed peritonitis.

History

- Regarding abdominal pain: ask about its onset, character, location, and radiation and if there have been similar episodes in the past.
- Inquire about associated symptoms: nausea, vomiting, change in bowel habits, new or chronic constipation or diarrhea, last bowel

movement and passage of flatus, GI bleeding, decreased appetite, weight loss, or fever.
- In the past medical hx, consider previous surgery, cancer, inflammatory bowel disease, peripheral vascular or coronary artery disease, hypertension, atherosclerosis, hypercholesterolemia, diabetes, cardiac arrhythmias, and alcohol or tobacco use.
- If the patient has had previous abdominal/pelvic surgery of any kind, SBO should be a diagnostic consideration.
- A change of bowel habits with constipation and/or diarrhea may indicate an LBO secondary to diverticular disease or to tumor. Melena, blood in stools, weight loss, and weakness may be indicative of colonic neoplasm. Chronic constipation can predispose to sigmoid volvulus.
- Seek reasons for underlying ileus; inquire about narcotics, bed rest and immobility, trauma, hypothyroidism, electrolyte deficiencies, and medications.
- Gradual and painless distention may be secondary to ascites. Ask about liver disease and hx of chronic alcohol abuse.

Physical Examination

- VS: Fever suggests an inflammatory process or strangulation or perforation.
- Tachycardia may reflect pain, dehydration, or sepsis. Hypotension may reflect dehydration and/or sepsis.
- Abdominal examination should identify scars and/or hernias. Marked tympany suggests bowel obstruction; peritoneal signs suggest ischemia and/or perforation. Distention with diffuse mild tenderness is consistent with obstruction or ileus. Lack of tympany and tenderness, along with a fluid wave, suggests ascites.
- Rectal examination is important: note the sphincter tone, presence of masses, and/or blood; Hemoccult any stool present.
- Look for clues in other parts of the physical examination, e.g., manifestations of vascular disease or the presence of an arrhythmia (atrial fibrillation would increase suspicion of an embolic event).

Tests for Consideration

- **CBC:** Leukocytosis suggests inflammatory process. Anemia raises concern for neoplasm. **$35**
- **LFTs:** If you suspect hepatobiliary disease by hx or physical examination. **$45**
- **Amylase/lipase:** Elevation would suggest pancreatitis. **$40**
- **Chem 7:** Look for signs of dehydration or acidosis. **$38**
- **Lactic acid or lactate:** Elevated in shock and bowel ischemia. **$25**
- **Colonoscopy:** Useful in determining etiology of LBO and decompression of colonic ileus. **$600**
- **Ultrasonography:** Useful to confirm ascites and to evaluate the liver. **$225**

IMAGING CONSIDERATIONS

➔**Obstruction series:** Erect CXR and two-view abdomen series to evaluate for pneumoperitoneum, bowel obstruction, or pulmonary process. Distended colon is distinguished by large haustral folds while thinner valvulae cross the entire width of obstructed loops of small bowel. Numerous air-fluid levels of differing heights are characteristic of obstruction. **$125**

➔**CT of abdomen/pelvis with oral/IV contrast:** Very useful in cases of bowel obstruction to show point of transition and possible causes. Oral contrast is helpful, but at times cannot be used due to nausea and vomiting. CT can gauge the severity of obstruction, look for free air and ascites. Aortic and splanchnic vessels can be evaluated during bolus IV contrast injection to help recognize mesenteric ischemia. **$750**

➔**Contrast enema:** May be helpful in determining etiology of LBO, especially when massively distended colon makes the CT difficult to interpret. Water-soluble contrast (Gastrografin) may be safest in these cases. **$250**

➔**Mesenteric angiography:** Now more commonly performed via CT angiography with rapid IV bolus and 3D computer reconstructions. However, intra-arterial catheter angiography has the added advantage of possible interventional angioplasty and stent treatment. **$1,325**

Clinical Entities — Medical Knowledge

Small Bowel Obstruction

Pφ *SBO* occurs when the normal flow of intestinal contents is impeded or interrupted, either by extrinsic compression or intrinsic blockage. In the majority of cases this will be due to postoperative adhesions; other causes include incarcerated hernias, neoplasms, intussusception, volvulus, and strictures. Fluid shifts lead to dehydration. With strangulated obstruction, compromised blood flow leads to necrosis, with the chance of perforation and sepsis.

TP SBO typically presents with diffuse, periumbilical, colicky abdominal pain accompanied by nausea and vomiting. Abdominal distention may be present. Localized pain associated with peritoneal signs suggests secondary ischemia.

Dx	Dx of SBO should be derived by hx and physical examination and confirmed by radiography. Plain radiographic findings include dilated loops of small bowel, paucity of air in the colon, and air-fluid levels seen on upright films. CT of the abdomen may demonstrate a transition point, and may be particularly useful to establish an etiology in patients without prior abdominal surgery.
Tx	Initial tx of SBO is fluid resuscitation and decompression of the GI tract. If there are no indicators of ischemia (tenderness, fever, leukocytosis), correct dehydration and electrolyte imbalances with IV fluids and decompress the bowel with a nasogastric tube. The majority of partial SBOs secondary to adhesions should be treated initially with nonoperative management, provided there are no peritoneal signs. If there are signs of complete obstruction, with or without ischemia, surgery is indicated. **See Sabiston 48, Becker 25.**

Large Bowel Obstruction	
Pφ	The majority of LBOs are secondary to adenocarcinoma, and the point of obstruction is most commonly the distal colon. Other causes include stricture (usually associated with diverticular disease or IBD), volvulus, and impaction.
TP	With obstruction due to neoplasm, antecedent symptoms are commonly found, such as constipation or other change in bowel habits. Abdominal distention is often accompanied by blood in the stool. Weakness, anemia, and weight loss may be associated.
Dx	Plain films of the abdomen are usually characteristic for dilated colon. Evaluation with rectal contrast enema, CT with rectal contrast, and/or colonoscopy may be warranted.
Tx	The tx for obstruction caused by a neoplasm or inflammatory stricture is surgical and involves appropriate resection. Regardless of the etiology, a complete LBO requires NG decompression, fluid resuscitation, and surgical intervention for definitive decompression that will most likely require creation of a colostomy. If bowel prep is possible, surgery with resection and primary anastomosis (with or without diverting ileostomy) is the tx of choice. **See Sabiston 50, Becker 21.**

Volvulus

Pφ ***Volvulus*** is the twisting of an air-filled segment of bowel around its mesentery and usually involves the sigmoid colon or the cecum.

TP Colonic volvulus, whether cecal or sigmoid, generally presents with more sudden onset of distention, pain, and nausea/vomiting. A hx of long-term, chronic constipation with sudden onset of acute symptoms should heighten the index of suspicion.

Dx Dx can usually be made with plain films of the abdomen. In sigmoid volvulus, the colon will have a coffee bean appearance and will point to the RUQ. In cecal volvulus the bean-shaped structure will be in the quadrant opposite the side of obstruction. A contrast enema (though not usually required for dx) would demonstrate narrowing of the lumen of the bowel in the shape of a bird's beak.

Tx Sigmoid volvulus can often be decompressed with sigmoidoscopy and the patient can be prepared for subsequent surgery; cecal volvulus usually requires surgical intervention. Prompt surgery will avert secondary infarction and perforation. **See Sabiston 50, Becker 21.**

Ogilvie's Syndrome

Pφ Colonic pseudo-obstruction is a condition in which the colon becomes massively dilated without actual obstruction. Known as Ogilvie's syndrome, it is often seen in institutionalized patients who are on narcotics and are bed-ridden and is thought to be caused by underlying autonomic dysfunction.

TP Distention may be accompanied by nausea/vomiting and obstipation, but in general, pain is not a predominant symptom unless there is an underlying inflammatory cause for the colonic ileus.

Dx Dx can usually be made with plain films of the abdomen that demonstrate diffuse colonic dilatation.

Tx Initial tx consists of bowel rest and correction of any associated electrolyte imbalance. Narcotics should be withheld if possible. Bowel dilatation of >9 cm increases the concern for possible ischemia and/or perforation and warrants decompression, either by administration of IV neostygmine or by colonoscopy. **See Sabiston 50, Becker 23.**

Ileus

Pφ ***Ileus***, sometimes referred to as "paralytic ileus," is frequently seen following abdominal surgery and can also occur secondary to an intra-abdominal inflammatory process such as appendicitis, diverticulitis, pancreatitis, or viscus perforation. Narcotics, bed rest, hypothyroidism, electrolyte deficiencies (potassium, calcium, magnesium, and phosphate), anesthesia, psychotropic medication, and systemic illness (such as sepsis, congestive heart failure, or pneumonia) also contribute to development of ileus.

TP Distention may be accompanied by nausea/vomiting and obstipation. Pain may be present if the underlying cause for the ileus is infectious or inflammatory.

Dx Dx can usually be made with plain films of the abdomen that demonstrate diffuse bowel dilation, including both the small bowel and large bowel. CT can be useful in select cases to help r/o an underlying inflammatory process.

Tx Tx of the underlying etiology should be undertaken and the patient kept at bowel rest (with NG decompression as needed) until the passage of flatus or stool indicates return of bowel function. **See Sabiston 48, Becker 23.**

Ascites

Pφ ***Ascites*** is usually secondary to cirrhosis and portal hypertension. Ascites due to malignancy may arise from peritoneal implants as seen in a variety of intra-abdominal (GI and GYN) malignancies.

TP Fluid wave and lack of tenderness on physical examination are characteristic. Ultrasonography and CT reliably detect ascites.

Dx Patients with ascites should undergo diagnostic paracentesis to characterize the fluid and r/o bacterial peritonitis. Often a positive cytologic dx is obtained and supported by a high LDH or CEA level. With cirrhosis, conservative tx is preferred with diuretics (spironolactone) and paracentesis as needed. If the condition proves refractory to these methods, transjugular intrahepatic portosystemic (TIPS) or peritoneovenous shunting (PVS) may be considered.

Tx Tx of malignant ascites depends on the histology and proper staging of the underlying malignancy. **See Sabiston 43, 53; Becker 19.**

Intestinal Perforation

Intestinal perforation is considered in Chapter 17, Free Air (Case 7). Abdominal distention due to intestinal perforation may be related to a primary process distending the bowel that results in perforation, or a perforation with resulting secondary ileus.

Acute Mesenteric Ischemia

Pφ Acute mesenteric ischemia is compromise of the blood supply to the intestine and consists of three distinct entities: (1) ***acute embolic mesenteric ischemia***, (2) ***acute thrombotic mesenteric ischemia***, and (3) ***nonocclusive mesenteric ischemia***.

(1) In ***acute embolic ischemia,*** emboli usually originate from a cardiac source and can occur in patients with atrial fibrillation or after myocardial infarction. (2) ***Acute thrombotic ischemia*** can occur with hypercoaguable states and as an acute event in patients with underlying chronic mesenteric ischemia due to atherosclerotic disease. (3) ***Nonocclusive ischemia*** represents a low-flow state in otherwise normal mesenteric arteries and is seen in patients with shock secondary to sepsis, hypovolemia, or low cardiac output.

TP ***Pain out of proportion to physical findings is the classic presentation in acute mesenteric ischemia.*** Nausea and vomiting may occur, but are nonspecific. Bloody diarrhea may occur secondary to mucosal sloughing.

Dx Leukocytosis, increased amylase, and lactic acid are all nonspecific indicators of ischemia. The gold standard in the dx of mesenteric ischemia is angiography. Emboli may be found in the SMA near the take-off of the middle colic artery; thrombus is more often found at the most proximal portions of the SMA.

Tx Surgical intervention is required for treating acute mesenteric ischemia due to emboli or thrombus, either in the form of thromboembolectomy or reconstructive bypass along with resection of nonviable bowel. Nonocclusive mesenteric ischemia is reversed by tx of the underlying disorder that has produced the low-flow state. **See Sabiston 66; Becker 25, 37.**

Neoplasm

Pφ ***Neoplasm,*** either benign or malignant, may lead to abdominal distention by mass effect with or without the presence of bowel obstruction or ascites. Histologic types include tumors of GI, ovarian, and retroperitoneal origin.

TP Abdominal distention is typically gradual in onset and may not be accompanied by other GI symptoms or tenderness.

Dx CT is generally the test of choice.

Tx Tx will be dependent on the site of origin and specific histology.

ZEBRA ZONE

a. **Gallstone ileus:** A gallstone large enough to cause a small bowel obstruction at the ileocecal valve has usually eroded from the gallbladder into the duodenum via a cholecystoenteric fistula resulting from untreated chronic cholecystitis. Suspect gallstone ileus when an SBO is diagnosed in the face of ***air in the biliary tree***. **See Sabiston 54, Becker 17.**

b. **Neoplasms of the small intestine,** including adenocarcinoma, lymphoma, and carcinoid tumors, can present with SBO. **See Sabiston 48, Becker 25.**

Practice-Based Learning and Improvement: Morbidity and Mortality Self-Assessment Form

Complication	Prolonged ileus
Type	Associated condition; unpreventable
Surgery performed	Small bowel resection and lysis of adhesions for bowel obstruction (5 hr operative time)
Patient's disease	54-year-old woman with SBO after hysterectomy
Presentation	Persistently high (>900 mL) NG tube output without passage of flatus or bowel movements postoperatively
Intervention	NG tube was left in place until signs of return of bowel function

Outcome	Passage of flatus and stool after 10 days, with decreased NG tube output; diet was slowly resumed
Risk factors	Extensive lysis of adhesions, with prolonged OR time and exposure of bowel to air
How were risks addressed?	Patient's NG tube output was carefully monitored. She was urged to ambulate and to use narcotics judiciously.
What happened?	Prolonged ileus after a long lysis of adhesions is common and is thought to be due to a number of factors, such as handling of the bowel and exposure to cool air.
What could have been done differently?	Minimize tissue handling and length of operation if possible.
Would outcome have been different?	Probably not

Interpersonal and Communication Skills

Explaining the Withholding of Analgesia

A challenge to the relationship between the patient and physician is the issue of withholding pain medications from a patient until the responsible surgeon is able to examine the patient. Withholding pain medication may be perceived by the patient as being dismissive or even cruel. It is important to explain to the patient that examination by the appropriate decision makers is required prior to the administration of significant doses of narcotic medication in order to obtain an accurate assessment of the problem. Careful, open exchange of information and an attempt to contact the responsible decision maker ASAP will hopefully lead to better patient understanding.

Professionalism

Principle: Patient Autonomy

The discussion in this chapter of Ogilvie's syndrome and institutionalized (possibly schizophrenic) patients brings up the issue of the patient who wants to leave the hospital against medical advice (AMA). This is certainly a challenge to the principle of "patient autonomy." In general, if a patient wants to leave AMA, it should be with the understanding of the risks to doing so. Crucial to this understanding is an assumption of competency (see below: *Patient Rights: Judging Competency and Civil Commitment*). A schizophrenic patient may have a reasonable cognitive capacity to understand a piece of information, but may lack the insight to appreciate its significance and implications. If it is your clinical judgment that the patient needs to stay in the hospital for tx and the patient does not appear competent to make medical decisions, this situation may require involuntary hospitalization. Mental illness is, in fact, one of the substantive criteria for civil commitment. This is a situation in which professionalism requires that you understand how to tap into the experts in your system who work with this problem more routinely.

Systems-Based Practice

Patient Rights: Judging Competency and Civil Commitment
Competency, or the ability to make responsible health-care decisions, is defined in terms of cognitive capacity and crosses disciplinary boundaries into the legal realm. Competency is determined legally by the court, not by a medical provider or family member. Though specific standards vary by state, four commonly agreed upon standards for determining competency include: (1) communication of choice, (2) understanding of relevant information provided, (3) appreciation of available options and consequences, and (4) rational decision making. If a patient lacks competence and requires medical tx, most states provide for the appointment of a guardian. People who are mentally ill and are a danger to themselves or others can be involuntarily hospitalized. In general, though it is state dependent, the three main substantive criteria for civil commitment are (1) mental illness, (2) danger to self or others, and/or (3) inability to provide for basic needs. Some states have enacted legislation that permits involuntary hospitalization of three other groups: those who are developmentally disabled, those with substance abuse problems, and minors who are mentally disabled. When such questions arise, it advisable to consult with hospital risk management and/or counsel early in the patient care process.

Chapter 19
Abdominal Pain and Hypotension in a 79-Year-Old Female (Case 9)

Jeffrey A. Claridge MD

Differential Diagnosis

Hemorrhagic Conditions				
Abdominal aortic aneurysm (AAA)	Traumatic injury: acute and occult			
Inflammatory/Infectious Conditions				
Ruptured appendicitis	Mesenteric ischemia	Bowel obstruction	Urinary sepsis	Neoplasm
Gastointestinal perforation	Pancreatitis	Volvulus	Biliary sepsis	

Editor's note: Several entities in this chapter have been considered in previous chapters. Clinical Entities boxes will be used to highlight the clinical issues when ***hypotension*** is present.

Speaking Intelligently

When I'm asked to see a 79-year-old female who presents with a hx of abdominal pain associated with hypotension, I worry. The first priority in an acutely ill patient is falling back to the ABC's (airway, breathing, and circulation). This patient needs rapid attention and intervention. She may initially just require IV fluids with large-bore IV access; however, one needs to be prepared for more. If she is unstable, a secure airway needs to be established via endotracheal intubation and ventilator support. The patient may need blood and/or blood products, and urgent operative intervention may be required. I rapidly try to determine the etiology of the hypotension. It is likely either secondary to hemorrhage or an infectious/inflammatory process. This patient will need to be monitored in the ICU.

PATIENT CARE

Clinical Thinking

- Remember: this is a situation in which you treat even as you take your hx.
- Pay attention to the ABC's. Be prepared to start two large-bore IVs and give fluids (2 L Ringer's lactate). Determine whether the patient is responding to initial IV fluid bolus.
- Think of the surgical conditions in the differential dx that lead to trouble quickly. Suspicion for ***ruptured AAA*** in this age group should be kept in the forefront of your mind, as this condition is hemorrhagic.
- Look for findings that mandate operative intervention: diffuse peritonitis, free air on upright CXR, or a large pulsatile abdominal mass.

History

- Determine the initial character and location of the pain.
- ***Duration of the symptoms:*** acute worsening of pain may suggest perforation; pain for days or chronicity suggests other inflammatory processes such as diverticulitis or inflammatory bowel disease.
- ***Prior surgical/medical hx (especially abdominal and vascular):*** A patient with known vascular disease is at risk for a ***ruptured aneurysm*** or ***mesenteric ischemia***.
- Hx of prior surgery may also r/o certain disease processes such as ***appendicitis*** or ***gangrenous cholecystitis***; if the patient has a hx of previous malignancy, what were the details?
- ***Anticoagulation medications:*** important for diagnosing ***occult traumatic injury*** and ***retroperitoneal hematoma***.

Physical Examination

- VS are key in this patient and should be checked frequently. Fever suggests an inflammatory process; its absence does not rule it out. (An elderly patient may not mount a febrile response or may be hypothermic secondary to overwhelming infection.) You would suspect this patient to be tachycardic; check if the patient is rate controlled with beta-blockers or calcium channel blockers.
- Hypotension can be associated with dehydration, sepsis, and hypovolemia or secondary to bleeding from a ruptured aneurysm.
- A large pulsatile mass suggests an ***aortic aneurysm***; hypotension suggests possible rupture.
- Peritoneal findings (tenderness, guarding, rebound) are likely in ***gastrointestinal perforation.***
- Complaints of abdominal pain out of proportion to physical examination findings suggest ***mesenteric ischemia***.

Tests for Consideration

- **CBC:** Leukocytosis suggests an inflammatory process. A low hematocrit suggests hemorrhage, and high hematocrit may suggest severe dehydration. $35
- **Type and cross** needs to be a priority in this patient. $45
- **Coagulation studies (PT, INR, PTT):** If the values are elevated and a hemorrhagic dx is made, correct any coagulopathy. $85
- **U/A** for pyelonephritis, nephrolithiasis, UTI. $38
- **Basic metabolic panel:** abnormalities need to be corrected. $75
- **Amylase/lipase:** may assist in the dx of pancreatitis. $85
- **LFTs:** will assist in assessing biliary sepsis. $125

IMAGING CONSIDERATIONS

➔***Upright CXR and Obstruction Series***: The first and virtually mandatory study in the ED is an upright CXR. Have the x-ray technologist continue to image the abdomen while awaiting the development of the upright CXR. If the patient is unstable and has peritonitis or intra-abdominal hemorrhage, the patient may warrant operative intervention without further testing. ***CXR*** **$75**

Free air: ➔to OR for surgical intervention.

No free air (unstable):

➔***Abdominal ultrasonography-STAT portable in ED***

If **free fluid** and concern for hemorrhage: to the **OR for surgical intervention.** If **no clear pathology**: stabilize and try to obtain CT ***US*** **$225**

No free air (stable):

➔***CT of abdomen/pelvis with oral/IV contrast*** or

➔***CT of abdomen/pelvis without oral contrast:*** In cases of dire emergency when questions remain about the diagnosis, a rapid CT without any contrast at all may drastically change patient tx. Temporarily delayed AAA rupture, retroperitoneal hemorrhage, and unseen free air can often be diagnosed quickly and easily. However, if the patient is stable and time allows, oral and IV contrast should be always be used. ***CT*** **$750**

Clinical Entities — Medical Knowledge

Abdominal Aortic Aneurysm

Pφ An aortic aneurysm is a dilatation of the aorta that is most commonly seen below the renal arteries.

TP The majority of patients who present with rupture have been asymptomatic. On physical examination they will have abdominal pain and a large expansile pulsation. The patient may be pale and diaphoretic.

Dx Dx and tx need to be rapid. Hx, physical examination confirmation, and hypotension are enough to warrant rapid operative intervention. The dx can also be supported with a KUB showing a calcified mass, ultrasonography, or CT.

Tx Tx in the case of hypotension involves immediate operative repair with a synthetic graft. Surgical tx for hypotensive patients with suspected AAA should not be delayed by unnecessary CT. **See Sabiston 65, Becker 38.**

Traumatic Injury: Acute and Occult

Pφ A patient's presentation with acute trauma is usually obvious. However, an elderly patient who presents with abdominal pain and hypotension needs to be asked about possible recent (past 2–3 days) traumatic injury. Elderly patients are at risk for falling and may be on antiplatelet or anticoagulation drugs.

TP The patient may have a solid organ injury and present hypotensive with progressive abdominal distention and pain.

Dx The hematocrit will likely be low, with the patient showing signs of hypovolemia. The dx can be confirmed with CT pending the patient's hemodynamic status.

Tx Tx depends on the injury detected. **See Sabiston 20, 67; Becker 11.**

Gastrointestinal Perforation

Perforated peptic ulcer disease of the stomach or duodenum as well as any intestinal or colonic perforation such as diverticulitis can present with abdominal pain, peritonitis, and hypotension. These diagnoses are considered in Chapter 17, Free Air (Case 7). **See Sabiston 46.**

Ruptured Appendicitis

Perforated appendicitis is the end result of an inflammation of the appendix. The likelihood of perforation increases with the duration of symptoms. And a patient with hypotension is likely to have perforated. Appendicitis is discussed in Chapter 11, Right Lower Quadrant Pain (Case 1). The dx is often more difficult in the elderly who frequently do not mount a febrile response. Tx is laparoscopic or open appendectomy. **See Sabiston 49, Becker 15.**

Perforated Diverticulitis

Perforated diverticulitis is a complication of diverticular disease that can result in a localized abscess or free abdominal perforation and is considered in Chapter 17, Free Air (Case 7). **See Sabiston 50, Becker 21.**

Neoplasm with Perforation

Neoplasms in the elderly are most often primary malignancies of the colon or metastatic disease within the abdomen. Whereas perforation is uncommon, a common scenario is that of distal total large bowel obstruction due to neoplasm with cecal dilatation and perforation. See discussion in Chapter 17, Free Air (Case 7). **See Sabiston 50, Becker 21.**

Bowel Obstruction

Pφ ***Small bowel obstruction, large bowel obstruction,*** and ***volvulus*** are all considered in Chapter 18, Abdominal Pain and Distention (Case 8). Hypotension is ominous and raises the concern for severe dehydration, inadequate resuscitation, perforation, or strangulated obstruction. **See Sabiston 48, 50; Becker 21, 25.**

Urinary Sepsis—Pyelonephritis/Cystitis

Pφ ***Pyelonephritis*** [discussed in Chapter 12, Right Upper Quadrant Pain (Case 2)] is an infection of the upper urinary tract most often caused by gram-negative organisms, most commonly *Escherichia coli, Klebsiella, or Proteus mirabilis*. *Enterococcus* (gram positive) is also common. *Pseudomonas aeruginosa* is often detected in hospital-acquired UTIs. The patient usually presents with fever and chills and back, flank, or abdominal pain. In the elderly, both cystitis and pyelonephritis can present with sepsis, hypotension, and mental status changes.

Biliary Infection/Sepsis

Pφ ***Gangrenous cholecystitis*** and ***ascending cholangitis*** related to obstruction of the common bile duct can also present with sepsis.

TP Patients may present with Charcot's triad: RUQ pain, fever, and jaundice.

Dx In both gangrenous cholecystitis and ascending cholangitis, leukocytosis will be present. Gangrenous cholecystitis is suggested by ultrasound and CT (intraluminal membranes, marked abnormalities of the gallbladder wall, pericholecystic fluid). In ascending cholangitis ultrasound and/or CT will often demonstrate CBD dilatation and intrahepatic ductal dilatation. MRCP offers a noninvasive assessment of the common bile duct.

Tx Gangrenous cholecystitis mandates IV fluids, appropriate antibiotics, and cholecystectomy. Patients with cholangitis and bile duct obstruction require decompressive interventions (ERCP or percutaneous transhepatic), which may be both diagnostic and therapeutic. **See Sabiston 54, Becker 17.**

Pancreatitis

As discussed in Chapter 13, Epigastric Pain (Case 3), pancreatitis can present as mild or severe disease. When it presents as abdominal pain and hypotension, one must assume severity. Prognostic indices should be calculated according to Ranson's criteria, which are discussed in Practice-Based Learning and Improvement: Evidence-Based Medicine in Chapter 13. **See also Sabiston 55, Becker 24.**

Mesenteric Ischemia

Mesenteric ischemia is considered in Chapter 18, Abdominal Pain and Distention (Case 8).

TP Abdominal pain and distention. Whereas the hallmark of early mesenteric ischemia is ***pain out of proportion to examination***, when mesenteric ischemia presents with hypotension, it suggests under-resuscitation and/or dead bowel. Urgent intervention is required. **See Becker 37.**

ZEBRA ZONE

a. **Retroperitoneal hematoma:** Spontaneous bleeding in the retroperitoneum is found in patients on anticoagulants or with a bleeding diathesis. It should be suspected in patients with recent venous or arterial catheterizations. **See Sabiston 43, 67.**

b. **Ruptured hepatic neoplasm:** Pain is associated with rupture of the liver capsule; hypotension is secondary to ongoing hemorrhage. **See Sabiston 52, Becker 18.**

c. ***Clostridium difficile* colitis:** Caused by an overgrowth of bacteria in the colon resulting in pseudomembranous lining of the colon. Associated with recent antibiotic administration. See Chapter 16, Abdominal Pain and Diarrhea (Case 6). **See Sabiston 15.**

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
Drotrecogin alfa (activated) for adults with severe sepsis and a low risk of death

Authors
Abraham E, Laterre PF, Garg R, Levy H, Talwar D

Institution
Multi-institutional study

Reference
New England Journal of Medicine, 2005 Sep 29;353(13):1332–1341

Problem
Drotrecogin alfa (Xigris) had been approved by the FDA for adults who had severe sepsis and a high risk for death. Was it similarly beneficial for patients with severe sepsis but a low risk for death (single-organ failure or an APACHE II score less than 25)?

Intervention
Adult patients with severe sepsis and a low risk for death were randomly assigned to receive Xigris or placebo.

Quality of evidence
Prospective, randomized, double-blind, placebo-controlled, multi-institutional trial of 2,640 patients with severe sepsis.

Outcome/effect
The trial was closed early because there was no tx benefit and an increased risk for serious bleeding complications.

Historical significance/comments
This study illustrates the need to rigorously test new drugs (even with established effectiveness) in various subsets of patients. (See Systems-Based Practice later in this chapter.)

Interpersonal and Communication Skills

Discussing End-of-Life Issues

A 79-year-old who presents with abdominal pain and hypotension may prove to have a disease process that carries a poor prognosis. In the elderly patient, this mandates a sincere and honest discussion with the patient and family about issues related to the patient's wishes for medical tx. It is important to assess the patient's life situation and attitude toward medical therapies. It may prove essential to ascertain the patient's wishes with regard to "end-of-life issues" such as DNR status. Making a dx rapidly will assist in providing objective information in this context. In extreme circumstances, a discussion of the *futility* of tx may be required. At times this calls for candid and sensitive discussion that continued interventions and tx will not change the fact that a loved one is dying, and it must be stated gently that the focus of further therapy should be on the patient's comfort.

Professionalism

Principle: Patient Autonomy

There are times when a family may wish to proceed with a surgical intervention when the patient has clearly communicated the desire ***not*** to proceed with surgery. In this case it is very important to support the patient's competent informed decision. This scenario is encountered frequently with critically ill patients and presents a very difficult challenge for the responsible physicians. For this reason, it is important to discuss and document the patient's wishes early and clearly.

There are times when the patient's wishes are unknown and family needs to decide for the patient. The surrogate is the person who is either the closest relative or an individual who is legally appointed. The surrogate's role is to ***make a decision for the patient as the patient would for him/herself.*** Often this decision comes from a consensus of close family members.

A difficult dilemma arises when the family is strongly divided. In these cases additional support can be provided from other physicians (consultants), an ethics team consultation, social workers, nurses, and/or religious representatives respected by the family.

Systems-Based Practice

Cost of Drugs and P&T Committee

Drotrecogin alfa (Xigris) therapy for the tx of severe sepsis in adults is very expensive, with a cost of approximately $42 per mg, approximately $7,000 per tx period for a 70-kg patient. Its use illustrates the major issue of how the system must work to incorporate new medications in order to advance medical care, yet be safe and cost effective. Before committing to the use of such new therapies, physicians and hospital administrators must work together to decide on the appropriateness of such new therapies. Most hospitals have a Pharmacy and Therapeutics Committee composed of clinicians, pharmacists, and hospital administrators that establishes cost-effective patient care.

If you have had the opportunity to evaluate a patient with abdominal pain, you are encouraged to review your patient's course in the context of the Competency Self-Assessment Form on page 35. This form can also be found as a Word document on the book's Web site on www.studentconsult.com, from which it can be printed or downloaded for building your patient-encounter portfolio. In your self-assessment, critique whether you are able to generate a broad differential diagnosis for causes of abdominal pain and whether you are able to recognize the signs and symptoms of a patient requiring surgical intervention.

Professor's Pearls: Abdominal Pain

Section Review

Consider the following clinical problems and questions posed. Then refer to the professor's discussion of these issues.

1) A 28-year-old female presents with a 2-day hx of vague periumbilical pain. Today the patient has lower abdominal pain (right greater than left), which is associated with new onset of urinary frequency. She also vomited twice today. She is sexually active and her menstrual cycle tends to be irregular. Her last menstrual period was 6 weeks ago (2 weeks late).

VS: T = 100.2, HR = 90, BP = 110/68.
Labs: H/H = 12.0/36.3, WBC = 11,300, U/A: 5 RBCs, 10–15 WBCs
Physical examination: RLQ tenderness, guarding, and rebound. Pelvic examination without cervical motion tenderness.

What would be your differential dx and plan for further evaluation?

2) A 44-year-old female presents to the ED with RUQ pain associated with nausea and vomiting. She states that this pain has been present for nearly a week, but she has failed to seek medical attention. She admits to having 2 to 3 "drinks" each night. Two years ago she had an episode of alcoholic hepatitis and she assumes that her current episode might be the same.

VS: T = 100.9, HR = 102, BP = 140/70
Physical examination: RUQ tenderness with guarding
Labs: H/H = 11.7/35, WBC = 14,600. Total bilirubin = 1.2, alkaline phosphatase = 92, AST = 86, ALT = 74, amylase = 47, lipase = 60
Imaging: RUQ ultrasonography shows "cholelithiasis, gallbladder wall thickening (5 mm), and a small amount of pericholecystic fluid."

Based on the information presented, what is the most likely dx and what would you recommend?

3) A 65-year-old male presents with diffuse mid-abdominal pain that awakened him 24 hours ago. He states that the pain initially presented as a sharp stabbing sensation in his mid-abdomen but has now worsened and is generalized.

The patient is actually well known to you because you performed a colonoscopy on him 3 days ago. He had been referred to you because of a hemoglobin of 8.0 and Hemoccult-positive stools. Your colonoscopy documented a 4-cm adenocarcinoma of the cecum. You have already scheduled an elective right colectomy for next week (to be preceded, of course, by an appropriate bowel prep). The patient's past medical hx is significant for use of NSAIDs for osteoarthritis over the past 3 years. The patient also has a hx of a single episode of acute diverticulitis 3 years ago that was treated as an inpatient with IV antibiotics.

VS: T = 99.3, HR = 110, BP = 110/70, RR = 22
Physical examination: Abdomen has diffuse rebound tenderness. The tenderness is greatest in the RLQ.
Labs: H/H = 8.3/25.2, WBCs = 18,400
Imaging: A CXR performed in the ED shows "free air under the diaphragm."

What are the diagnostic possibilities? What further workup do you need and what would be your tx approach?

4) A 32-year-old female presents with a 2-day hx of RLQ tenderness associated with 3 loose stools. The patient describes 4 episodes of severe but self-limited diarrhea earlier this year. One such episode precipitated an ED visit without specific dx. She has had an 8-pound involuntary weight loss over the past 2 months. She is currently experiencing her menstrual period, but the pain is "not my usual menstrual cramps."

VS: T = 99.2, HR = 90, BP = 110/68
Physical examination: RLQ tenderness, guarding, and mild rebound. Pelvic examination is unremarkable. Questionable right CVA tenderness.
Labs: H/H = 12.1/36, WBC = 11,800, U/A: many RBCs and 0–5 WBCs

What are the diagnostic possibilities? How would you work this up further?

5) A 67-year-old male who is 6 years status post left colectomy for stage III carcinoma of the colon presents with acute onset generalized crampy abdominal pain and mild abdominal distention. He is known to be hypertensive with atherosclerotic vascular disease and chronic atrial fibrillation.

VS: T = 99.0, P = 106, BP = 152/94
Physical examination: The abdomen is mildly distended but soft, with no localized tenderness. Bowel sounds are present.
Labs: H/H = 12.2/37, WBC = 13,400.
Imaging: Obstruction series shows nonspecific gas pattern with a few air-fluid levels.

What are the most likely diagnoses? Which one causes you most concern and how would you proceed in your workup?

Discussion by Bruce E. Stabile, MD, Chair, Department of Surgery, Harbor–UCLA Medical Center

Answer 1

Diagnostic Priorities: appendicitis, r/o UTI and ectopic pregnancy.

This patient has the characteristic prodrome for appendicitis with periumbilical pain migrating to the RLQ and associated with localized peritoneal findings. I would definitely check the β-hCG before proceeding with appendectomy, particularly in light of the patient's delayed menstrual period. Ectopic pregnancy must be r/o. The abnormal U/A result may relate to bladder irritation from an inflamed appendix or represent the additional problem of a UTI. Though the clinical picture is most consistent with appendicitis, preoperative CT is in order if the β-hCG is normal.

Answer 2

Diagnostic Priorities: acute cholecystitis (doubt alcoholic hepatitis or pancreatitis).

This patient has a hx and clinical examination findings compatible with acute cholecystitis. The physical examination could also be indicative of acute alcoholic hepatitis; however, with the ultrasound highly suggestive of acute cholecystitis, and the absence of substantial transaminase elevation, the dx of alcoholic hepatitis is extremely unlikely. With no prior hx of pancreatitis, the duration of pain in the face of completely normal amylase and lipase levels makes the dx of acute pancreatitis virtually untenable.

Urgent cholecystectomy should be advised. Given that this process has "smoldered" for nearly a week, the gallbladder may be so inflamed that laparoscopic cholecystectomy becomes a major challenge. As for all laparoscopic cholecystectomies, consent should be obtained from the patient for possible open cholecystectomy as well.

Answer 3

Diagnostic Priority: perforated bowel until proven otherwise.

Based on the CXR, we know that the patient has free air under the diaphragm and, therefore, perforation of a hollow viscus. Given the complicated hx, the possibilities include (1) perforated ulcer related to NSAID use, (2) perforated colon related to the colonoscopy, (3) perforated diverticular disease, and (4) perforation of the cecal tumor (less likely). No further diagnostic studies need to be performed. The patient should be adequately resuscitated with IV fluids, given broad-spectrum antibiotics, and taken to the OR urgently. If the patient has a colonic perforation on the left side related to a diverticulum or the prior colonoscopy, I would perform a subtotal colectomy to include the cecal tumor. Primary ileocolonic or ileorectal anastomosis versus ileostomy and closure of the distal colon or rectum would depend on the degree of contamination that I find. If there is a perforation of the cecal tumor or right colon, a right colectomy and ileotransverse colonic anastomosis usually can be performed safely, thus eliminating the need for ileostomy. If the patient proves to have a perforated peptic ulcer, I would perform a simple suture closure or Graham patch of the stomach or duodenum and perform a right colectomy at this time unless the degree of contamination prevents me from doing so.

Answer 4

Diagnostic Priorities: appendicitis, inflammatory bowel disease (Crohn's), ureterolithiasis.

Whereas this clinical presentation could represent appendicitis, the episodes of intermittent diarrhea place inflammatory bowel disease (Crohn's) high on my differential dx. With RLQ pain, questionable CVA tenderness, and hematuria, one should also think of ureterolithiasis. However, the apparent hematuria is most likely related to the patient's menstrual period.

CT should differentiate between appendicitis and Crohn's, where I would expect to see well-defined ileal thickening. If the CT is nondiagnostic, laparoscopy should be performed. If appendicitis is found, laparoscopic appendectomy is performed if technically possible. If not, the operation must be converted to open appendectomy. If during laparoscopy I see "creeping fat" and an inflamed distal ileum (characteristic of Crohn's), I would perform an appendectomy, provided the base of the appendix is not involved. The patient should then be treated medically for Crohn's postoperatively.

Answer 5

Diagnostic Priorities: mesenteric ischemia, small bowel obstruction, recurrent colon carcinoma.

Though this patient's presentation may be consistent with a small bowel obstruction due to adhesions or even recurrent colon carcinoma (somewhat unlikely after 6 years), my overriding concern is that of mesenteric ischemia. Given the patient's hx of vascular disease and atrial fibrillation, he is at high risk for an embolus or thrombosis of the superior mesenteric artery that supplies the entire midgut. In the early stages, it would be classic to have severe abdominal pain in the absence of peritoneal findings. This is the condition that must be investigated first.

CT angiography of the abdomen should be diagnostic. Angiographic intervention should be considered if it is early in the course, nonocclusive mesenteric disease is found, and the bowel is thought to be viable. If there is any concern about bowel viability, or an acute arterial occlusion is found, exploratory laparotomy should be performed emergently.

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Chapter 20
Abnormal Screening Mammogram in a 48-Year-Old Female (Case 10)

Paula M. Termuhlen MD

Differential Diagnosis

What entities would cause a mammographer to determine that a screening mammogram is abnormal?

Calcifications	Mass	Architectural distortion	Lymph nodes

Speaking Intelligently

When I'm asked to see a 48-year-old female who presents with an abnormal screening mammogram, I ask if the mammogram was truly a screening mammogram or was it prompted because the patient or her physician discovered an abnormality in her breast. I inquire about associated symptoms (e.g., nipple discharge, lumpiness, skin changes, or tenderness) and I determine menstrual hx. I probe for risk factors (e.g., family hx of breast cancer or previous biopsies). Most nonpalpable abnormalities found on mammography that are suspicious for malignancy will require an image-guided biopsy (stereotactic, ultrasound-guided, or needle-guided excisional biopsy) for dx so I try to prepare the patient for this at first consultation.

PATIENT CARE

Clinical Thinking

- Screening mammograms have been shown to detect malignant lesions at earlier stages and decrease risk for mortality from breast cancer by 35% to 40% in women over the age of 50, and by 23% to 30% for women between 40 and 50.
- The National Cancer Institute, the American Cancer Society, and the American College of Radiology all recommend annual (once a year) mammograms for women over 40.
- When a mammogram has been determined to be abnormal, it is incumbent upon the breast expert to determine if there is an occult malignancy.

History

- Consider why the mammogram was obtained: Was it truly a screening mammogram or was it prompted by a concern noted by the patient or her physician?
- Inquire about lumpiness, skin changes, nipple discharge, and tenderness associated with the menstrual period.
- Is this a new finding in a patient who routinely performs breast self-examination (BSE) or an accidental finding in someone who does not do BSE?
- Ask about a hx of previous aspirations or biopsies and the pathology from those biopsies.
- Note the age of menarche, menopause, and the age at her first full-term pregnancy.
- Obtain a family hx of breast or ovarian cancer (noting age of onset).

Physical Examination

- Breast examination is considered in Chapter 21, Breast Mass (Case 11).

IMAGING CONSIDERATIONS

➔**Bilateral screening mammography:** Initial examination, two views only of each breast: mediolateral and cranio-caudad. **$155**

➔**Diagnostic mammography:** A radiologist should be actively involved: magnification, spot compression, and additional views of any suspicious areas are obtained as needed. **$175**

➔**Ultrasonography:** Handheld, high-frequency ultrasonography determines if the mass is cystic or solid. Can be used for guidance to perform a needle biopsy. **$225**

For more on breast imaging see Imaging Considerations in Chapter 21, Breast Mass.

Clinical Entities — Medical Knowledge

Calcifications

Calcifications signify deposition of calcium in the breast tissue. Calcifications are divided into three types: ***benign, indeterminate,*** or ***high probability of malignancy***.

Benign calcifications may be coarse, rodlike, associated with blood vessels, round, popcorn shaped, or milk of calcium (concave) (Fig. 20-1).

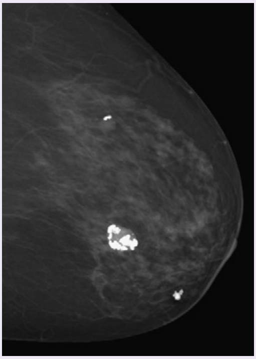


Figure 20-1 "Fibroadenoma" or benign calcifications. Note "popcorn calcifications" associated with old degenerative fibroadenoma.

Malignant calcifications are more likely pleomorphic, heterogeneous, clustered, linear, or branching. Linear, branching calcifications are commonly associated with ductal carcinoma in situ (Fig. 20-2).

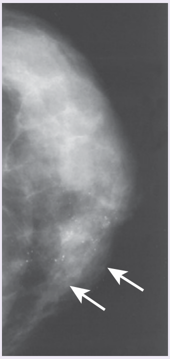


Figure 20-2 Clustered microcalcifications. Note the clustering of fine, pleomorphic, and linear calcifications. The diagnosis was ductal carcinoma in situ. These findings may also be associated with invasive breast cancer.

Calcifications are also associated with atypical ductal hyperplasia, a common premalignant lesion.

Benign Mammographic Masses

Masses in the breast are space-occupying lesions seen on at least two views of the mammogram. Well-circumscribed and smooth masses are suggestive of a benign etiology.

The typical benign mass is either a cyst or a fibroadenoma. Ultrasonography will differentiate (Fig. 20-3).

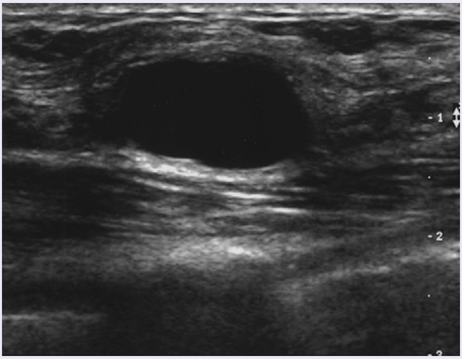


Figure 20-3 Ultrasound of a simple breast cyst. Note smooth borders, absence of internal echoes, and enhanced posterior echoes.

Note: *10% to 15% of cancers may present as smooth masses, particularly in the elderly population*. **See Sabiston 34, Becker 40.**

Mammographic Mass—Malignant

Malignant masses are typically irregular, spiculated, and often contain calcifications, as shown in Figure 20-4.

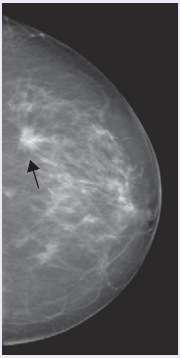


Figure 20-4 Dense stellate mass. The spiculated borders and distortion of surrounding breast architecture suggest malignancy

Architectural Distortion

Architectural distortion may be the earliest sign of breast cancer. (Some distortions are also associated with scars from previous biopsies or surgery.) See Figure 20-5.

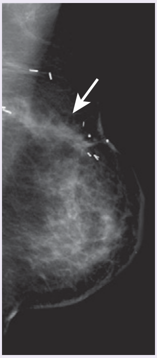


Figure 20-5 Architectural distortion. Note distortion from surgical scarring. Clips mark area of previous surgery

Accordingly, following any breast biopsy, it may be recommended that a new follow-up baseline mammogram be performed at a 6-month interval following surgery. When a mammogram is performed following surgery, scars are marked externally to aid in identifying architectural distortions within the breast. Biopsy is indicated only if recurrent cancer is suspected.

Interpersonal and Communication Skills

Choosing Language Carefully
A 48-year-old female about to undergo a biopsy for a mammographic abnormality is understandably anxious about both the possibility of cancer and the invasive procedure itself. When you suspect an abnormality may prove malignant, it is important to prepare a patient for the possibility of cancer. In the case where a patient's problem has presented as a mammographic abnormality, it is often fair to reassure the patient that even "if a cancer diagnosis is obtained, it's good that we're finding it very early." Most importantly, once the results of a biopsy are available, they should be conveyed to the patient without delay.

Professionalism

Principle: Primacy of Patient Welfare
When a screening mammogram is determined to be technically inadequate, a woman will be called back to the mammography department for further films. This is usually accomplished by letter

or telephone contact. The patient will frequently assume that a malignancy has been detected and her anxiety will be high. There are many such cases where no actual abnormality has been detected, but the mammographer has simply concluded that the technique or reach of the mammogram was inadequate. On such occasions it is appropriate for the mammography department to let the patient know that the reason for the repeated test is related to inadequate films, not a high suspicion for malignancy.

Systems-Based Practice

Standardization of Clinical Information: Breast Cancer
The BI-RADS lexicon is a system approach to standardize common language and to facilitate communication between radiologists, referring physicians, and patients. This is a systems-based approach to reporting the results of mammography. Table 20-1 explains the BI-RADS lexicon.

Table 20-1 BI-RADS

BI-RADS Category	Assessment	Clinical Management Recommendation(s)
0	Assessment incomplete	Need to review prior studies and/or complete additional imaging
1	Negative	Continue routine screening
2	Benign finding	Continue routine screening
3	Probably benign finding	Short-term follow-up mammogram at 6 mo, then every 6–12 mo for 1–2 yr
4	Suspicious abnormality	Tissue diagnosis should be strongly considered vs. 6 month follow-up
5	Highly suspicious of malignancy; appropriate action should be taken.	Tissue diagnosis must be obtained
6	Known biopsy—proven malignancy, treatment pending	Assure that treatment is completed

From the American College of Radiology: Breast Imaging Reporting and Data System Atlas (BI-RADS Atlas). Reston, VA: American College of Radiology, 2003.

Chapter 21
Breast Mass in a 44-Year-Old Female (Case 11)

Roxane Weighall DO, Jennifer L. Sabol MD, and Ari D. Brooks MD

Differential Diagnosis

Malignant mass	Fibroadenoma	Cyst	Benign breast nodularity

Speaking Intelligently

When evaluating a breast mass, I am always thinking about the ***triple test*** (clinical examination, imaging, pathology). I examine the patient paying attention to the characteristics of the mass and I review the mammogram or ultrasound to determine my level of suspicion. If my level of suspicion warrants a tissue dx, I use the least invasive biopsy technique that will yield an accurate dx. In the case of a palpable breast mass, this is most often a fine-needle aspiration biopsy or a core needle biopsy. Occasionally, though I may suspect that the mass represents benign breast nodularity, biopsy is still recommended for peace of mind (sometimes mine, often the patient's).

PATIENT CARE

Clinical Thinking

- The ***triple test:*** **clinical examination**, **imaging**, and **pathology** are three important tools to determine the dx of a breast mass. If all are not concordant with your dx, further workup is needed.
- The differential dx of a breast mass stays consistent, but the likelihood of malignancy changes with the patient's age. The older the patient, the more likely the mass is malignant.
- I try to obtain a tissue dx via a needle biopsy, avoiding open biopsy when possible. This enables me to plan a single definitive operation for cancer in many instances.

History

- Obtain information concerning the mass in question: How long has the mass been present? Has it increased or decreased in size? Is there associated pain or tenderness? Is the pain cyclical with the patient's menstrual cycle? Are there skin changes? nipple discharge?
- When was the patient's last menstrual period?
- Is there a personal or family hx of breast or ovarian cancer (maternal or paternal)?
- Any hx of previous breast biopsies? If so, does the patient know the pathological dx? (Look for a hx of *atypical ductal* or *atypical lobular hyperplasia*, or *lobular carcinoma in situ*, as these increase the patient's risk for developing breast cancer.)
- Is the patient taking exogenous hormones?

Physical Examination

- Having a chaperone present is a good idea when performing a breast examination if you are a female, *and a necessity if you are a male.*
- Breast examinations should be performed both in the upright and supine positions in a gown that is open in the front.
- Examine the cervical region and supraclavicular lymph nodes. (It is often perceived as less threatening to touch the neck and supraclavicular fossa first and then the breast.)
- In the upright position, examine the axillae; push the fingertips against the chest wall after having the patient place her *relaxed* arm on your shoulder; now run your fingertips downward along the chest wall—this will trap any nodes against the ribs.
- While examining in the upright position, have the patient raise her arms over her head. Observe for symmetry, skin changes, or obvious masses. Have the patient place her hands on her hips and press down, looking for skin dimpling or breast distortion. Lift the breasts gently, palpating with a sweeping motion.
- Assist the patient to lie supine or in a reclining position. Examine the breast with the pads of the fingertips in an organized fashion such as in concentric circles or radially. It is important to develop a system by which you examine ***all*** of the breast tissue. Do not become distracted by an obvious abnormality and forget to examine the remaining tissue. As a rule, it is better to examine the unaffected breast first.
- Remember that breast tissue can extend to the edge of the sternum, the clavicle, below the inframammary fold and to the midaxillary line
- Determine if there are any areas that are tender, and ask the patient to show you any areas about which she may have concern. Ask if the area is best appreciated in the upright or supine position. Reexamine the patient after she identifies areas of concern.
- When you are palpating a breast mass, be thoughtful about the texture: Is it rubbery or hard, smooth or nodular? Note carefully the size and shape of any masses: discrete or nondiscrete. Note mobility:

Is the lesion movable? Is it fixed to the skin overlying it or to the muscle beneath it?

- Document your findings in the chart. This should include a sketch and description of the abnormality (size, position on the clock, and distance from the nipple) as well as a plan of action.
- Be sure to discuss your findings with the patient.

IMAGING CONSIDERATIONS

➔**Bilateral screening mammography:** Initial examination, two views only of each breast. Report must use BI-RADS category and assessment.	$155
➔**Diagnostic mammography:** A radiologist is actively involved in a diagnostic mammogram. Magnification, spot compression, and additional views of any suspicious areas are obtained as needed.	$265
➔**Ultrasonography:** Problem solver, not for screening. Handheld, high-frequency ultrasonography determines if a mass is cystic or solid. Can be used for guidance to perform a needle biopsy.	$235
➔**MRI:** Problem solver, not for screening. Must use dedicated breast coils, MRI contrast, and experienced interpreters. Valuable adjunct in genetically high risk or in mammographically dense breasts. Preoperative value in planning therapeutic strategy.	$2500
➔**PET:** Standard whole body PET of no value in breast diagnostics, but can be used in staging.	$2900
➔**Needle biopsy:** Ultrasound guided for nonpalpable lesions. Rapid, reliable; performed in office or breast center.	$590
➔**Stereotactic biopsy:** Requires specialized table and computer-guided x-ray technique. Lesion must be identified on mammogram. Outpatient hour-long procedure with immediate discharge to home from breast center.	$2400
➔**Open biopsy:** The “Needle Loc,” mammographically guided placement of hooked guide wire for open surgical excision of tissue. Same-day surgery unit; takes a morning.	$4500

Clinical Entities — Medical Knowledge

Malignant Mass

Pφ The common malignant breast masses are *invasive ductal carcinoma* and *invasive lobular carcinoma*.

TP **Infiltrating (or Invasive) Ductal Carcinoma.** The typical patient has a firm dominant mobile mass found by self-examination or by a health-care practitioner. May be associated with skin retraction, palpable adenopathy, and/or nipple discharge. In the more advanced stages, the mass may be fixed to surrounding structures and associated with erythema, skin edema, peau d'orange, and matted axillary nodes. A carcinoma may be nonpalpable and present as an unexpected density on the screening mammogram. Often in retrospect you can feel a vague density in the area of mammographic concern.

TP **Invasive lobular carcinoma** represents only 5% to 10% of breast cancers and is classically more difficult to identify mammographically as well as on palpation due to its classic single cell (Indian file) growth histologically. Lobular carcinoma is often perceived as a "thickening" rather than as a discrete mass, and what you feel or see may be only the tip of the iceberg. The final pathologic size of an invasive lobular cancer is often much greater than anticipated due to this growth pattern.

Dx Tissue biopsy is essential to confirm the dx of a malignant mass. If the lesion is palpable, a fine-needle aspiration or percutaneous core needle biopsy can be performed in the office. (Many surgeons prefer to be sure a mammogram is obtained first in order not to confuse the mammographic picture by hematoma related to needle biopsy.) Ultrasound guidance or stereotactic guidance may be utilized for dx if the lesion is not palpable. Open incisional or excisional biopsies are appropriate when needle biopsy cannot be performed or is inconclusive.

Tx Management of breast carcinoma: For the patient presenting with a newly diagnosed breast cancer, the multiple treatment options available for local control can be confusing. I try to simplify these choices as much as possible and describe the options of **mastectomy** and **breast conservation** to the patient.

- ***Mastectomy* with *Sentinel Lymph Node (SLN)*** *biopsy* for nodal evaluation. If lymph nodes are involved, a complete axillary dissection is warranted, making the procedure a modified radical mastectomy.

OR

- ***Breast Conservation therapy***, which consists of: **lumpectomy to negative margins, Sentinel Lymph Node (SLN) biopsy** (+ completion axillary dissection if LNs are involved) **+ radiation therapy.**

These local treatment choices for invasive carcinoma are **equivalent in terms of overall survival.** After mastectomy local recurrence is 1% to 4% versus 7% to 10% following breast conservation.

After pathologic staging is obtained by definitive surgery, ***adjuvant chemotherapy*** and/or hormonal therapy is prescribed for most women. Radiation therapy is generally not required in patients undergoing mastectomy except in patients who are determined to be at high risk for local recurrence. Such instances include tumors > 3 cm, positive margins for invasive cancer, four or more lymph nodes involved with cancer, and extracapsular extension in a nodal metastasis. These recommendations are continually being reevaluated.

Tumor characteristics that should be determined are:

- *Hormone receptor status (estrogen and progesterone receptors)*—Positive hormonal receptors are a good prognostic sign.
- *Her 2-neu status*—Overexpression of the gene is a negative prognostic sign but indicates the patient can be treated with Herceptin, a specific antibody therapy directed at this marker. **See Sabiston 34, Becker 40.**

Fibroadenoma

Pφ ***Fibroadenomas*** are well-circumscribed, solid masses. They contain fibrous and epithelial elements and are thought to represent benign hyperplastic lobules. The cut surface is white or yellow and bulging beyond its pseudocapsule.

TP Fibroadenomas may appear at any age. The typical patient is between 15 and 35.

Dx Physical examination demonstrates a smooth, well-circumscribed mass that is mobile and rubbery in texture. Ultrasonography shows a mass with smooth margins and benign characteristics. In older women, “popcorn calcifications” may be associated with involuting fibroadenomas. Core needle biopsy confirms the dx.

Tx Small asymptomatic fibroadenomas do not need to be excised. However, excision is recommended if there is evidence of growth, an inconclusive needle biopsy result, size greater than 2 to 3 cm, or for symptoms. **See Sabiston 34, Becker 40.**

Cyst

Pφ ***Cysts*** are round to oval, well-circumscribed masses that may be single or multiple. They are fluid-filled benign sacs located within the fibrous tissue of the breast.

TP Cysts are common in patients undergoing hormonal fluctuations. They are common in premenopausal women and around the time of menopause.

Dx On examination, cysts are smooth, often ballotable, and frequently tender. On mammography, cysts have a smooth distinct border. Ultrasonography will easily confirm the presence of fluid and has a diagnostic accuracy of close to 100%. Cysts may fluctuate in size or present over serial examinations.

Tx Asymptomatic simple cysts do not require tx. Reasons to aspirate include for dx (the mass must resolve completely), to resolve pain, or to confirm the dx of a complex cystic mass on ultrasonography. Cyst fluid can range from thin pale yellow serous fluid to thick yellow to dark greenish brown and still not be considered abnormal or require cytology. **Bloody fluid** should always be sent for cytology and the patient reevaluated by imaging with the possibility of biopsy in mind. **See Sabiston 34, Becker 40.**

Benign Breast Nodularity

Pφ Normal breast tissue can have a nodular pattern in some women. This is more marked in the upper outer quadrants and is often very tender in response to normal cyclic hormonal variations. This cyclic tenderness is more pronounced as women become perimenopausal, and often one breast is affected more than the other.

TP The typical patient is premenopausal and complains of an intermittently tender mass that seems to fluctuate in size. The pain is characteristically worse in the 7 days prior to her menstrual period and then begins to abate with the onset of menses.

Dx Mammography and ultrasonography typically show normal breast tissue.

Tx Despite negative imaging studies, a biopsy should be performed to r/o malignancy if a dominant palpable mass is present and felt to be suspicious or if a woman's anxiety requires it. **See Sabiston 34, Becker 40.**

ZEBRA ZONE

a. **Phylloides tumors** are stromal tumors that may grow rapidly to large sizes, resembling fibroadenomas microscopically. They may be locally recurrent, and 10% are frankly malignant with the ability to spread hematogenously like sarcomas. Tx is wide local excision. **See Sabiston 34, Becker 40.**

b. **Metastatic deposits:** The breast can be a site for metastatic deposits from other malignancies, although this is rare. One of the most common lesions in this category is lymphoma.

c. **Trauma:** A hematoma due to trauma can cause a clinical mass. Later in the course, the mammographic appearance may be similar to that seen in malignancy; "fat necrosis," a frequent consequence of trauma, may leave an irregular mass, often containing calcifications. **See Sabiston 34.**

Practice-Based Learning and Improvement: The NSABP as a Model of Collective Practice-Based Improvement

Jennifer L. Sabol MD

The Accreditation Council on Graduate Medical Education emphasizes practice-based improvement as one of the core competencies of resident training. The National Surgical Breast and Bowel Project (NSABP) epitomizes the importance of this concept and clearly demonstrates how the application of clinical trials has led to significant advances in the management of breast cancer. The NSABP is a multi-institutional and multinational research organization that was founded in 1958 to address controversial issues in breast (and subsequently colon) cancer care. At the time of its establishment, the reigning theory of breast cancer promulgated by Halstead was that breast cancer spread in a stepwise local fashion from one point to the next and that this spread had a predictable timeline. Based on this principle, the radical mastectomy became the standard of care for all patients with breast cancer, regardless of tumor size. In the 1960s, Bernard and Edwin Fisher recognized circulating tumor cells in the blood of all breast cancer patients and proposed the then radical hypothesis that breast cancer is a "systemic" disease from its inception and that radical surgery may be unnecessary for the majority of patients. The NSABP B-04 trial, initiated in 1971 comparing radical mastectomy and simple mastectomy plus radiation, provided evidence that less radical surgery could provide equal survival, ultimately serving as the foundation principle for breast conservation therapy and thus enhancing quality of life for many women with a dx of breast cancer.

Table 21-1 Selected NSABP Trials

Study/Years	Questions Asked	How	Outcome and Comments
B-04 1971–1974	Is a radical mastectomy needed to improve breast cancer survival? Does lymph node dissection improve survival?	1,765 patients were randomized to radical mastectomy vs. simple mastectomy + radiation.	Radical mastectomy does not improve survival (no difference at 25 yr in any group). Lymph node removal/treatment does not alter survival, but there was an increase in axillary recurrence (18% vs. 5% LR). Interestingly, local control of the axilla was the same with either surgery or radiation.
B-06 1976–1984	Is partial mastectomy (lumpectomy) equivalent to modified radical mastectomy for survival?	2,163 patients were randomized to modified radical mastectomy, lumpectomy/AxLND,* or lumpectomy/AxLND + radiation.	Breast conservation is equivalent to mastectomy for survival. The only difference is in local recurrence, and adding radiation improves local control (10% vs. 39%).
B-14	Does tamoxifen improve survival after surgery for patients with estrogen receptor–positive tumors?	Estrogen receptor–positive/lymph node–negative patients were randomized to placebo or tamoxifen for 5 years.	Tamoxifen improved survival in pre- and postmenopausal women; this effect persisted over 15 yr of follow-up. A follow-up study re-randomized patients at 5 yr to either tamoxifen or placebo. This showed a significant *decrease* in survival in patients continuing on tamoxifen. This is counterintuitive and emphasizes the importance of randomized treatment trials to determine optimal treatment regimens.
B-17 1985–1990	Does radiation therapy reduce local recurrence in patients with noninvasive breast cancer (DCIS)?	818 patients had partial mastectomy then were randomized to radiation or no radiation.	Radiation improved local control (from 16.8% to 7.7%) and reduced new invasive cancers (from 50% to 30%), but did not influence survival.

B-18	Does chemotherapy prior to surgery improve survival over post-op adjuvant therapy?	1,523 patients were randomized to chemotherapy preoperation vs. postoperation.	Preoperative chemotherapy allowed more patients to undergo BCT (68% vs 60%), but did not change survival The study noted that a pathologic complete response resulted in better prognosis.
B-21 1989–1998	Is tamoxifen as effective as radiation therapy in preventing recurrence?	1,009 patients were randomized to lumpectomy/radiation therapy/tamoxifen, lumpectomy/radiation therapy/placebo, or lumpectomy/tamoxifen.	Radiation therapy plus tamoxifen was most effective for decreasing the rate of local recurrence, then radiation therapy alone, then tamoxifen alone (3% vs. 9% vs. 16%). None of the treatments changed overall survival. Incidentally, a 50% reduction in *contralateral* carcinoma was noted with tamoxifen use. This finding prompted the first prevention study (see P-1 below).
B-31 2000–2005	Does adjuvant herceptin in HER2-neu–positive cancers improve survival?	2,130 lymph node–positive, HER2-positive patients got chemotherapy then were randomized to get herceptin or not.	The trial was stopped early at 3 yr when interval analysis suggested a significant improvement in survival. The data were combined with another major cooperative group study (NCCTG) to report a 52% reduction in recurrence and a 33% reduction in mortality when herceptin is used as adjuvant therapy.
P-1 1992–1997	Can tamoxifen prevent breast cancer?	13,288 high-risk women were randomized to tamoxifen vs. placebo.	5 years of tamoxifen reduced the invasive and noninvasive cancer risk by 49%. This was the first trial showing that cancer can be prevented.
P-2 1999–2004	Which drug is better for preventing breast cancer, tamoxifen or raloxifene?	19,747 high-risk women were randomized to tamoxifen vs. raloxifene.	No significant difference in the amount of risk reduction. Raloxifene has a better safety profile but may not provide the same protective effect against noninvasive cancers as tamoxifen.

*AxLND = axillary lymph node dissection

In addition to providing the framework for randomized prospective tx trials, the NSABP has provided pathologic material for *retrospective* analyses as new concepts have been advanced in prognostic indicators and response patterns to tx. The more recent NSABP studies have collected a repository of tumor tissue and blood samples to be used for *future* research. The National Cancer Institute has recognized this database as a "national treasure."

To date, over 500 participating institutions and more than 110,000 patients have participated in clinical trials. Selected contributions made by the NSABP in the management of breast cancer are listed in Table 21-1. For additional information on past, present, and future protocols as well as links to the published data, visit the NSABP Web site at www.nsabp.pitt.edu.

Interpersonal and Communication Skills

Including Patient in Decision-Making Process

Patients need to feel that they are a part of the decision-making process. I often see a patient for a second opinion because the patient felt the initial surgeon became angry when the tx recommendation was questioned. Patients have a right to decide what care they will receive and each patient needs to feel comfortable with her decision. If a patient is struggling with a decision about her tx, I encourage the patient to seek other opinions from surgeons, medical oncologists, radiation oncologists, and her primary care provider. If a patient does not want to proceed with *my* recommendation, I respect her decision and try to help in any way I can.

Professionalism

Commitment to Improving Access to Care

Today, 47 million people in the United States are uninsured. No woman with a breast mass should be denied access to evaluation and care. Most communities have philanthropic resources to cover the cost of care in such instances. Physicians who care for women with potential breast malignancies should advocate for these types of resources and should know where to refer women who lack insurance coverage for expeditious care.

Systems-Based Practice

Standardization of Clinical Information

The TNM staging system was developed nearly 50 years ago to standardize cancer staging and enhance quality of care. In the era of the multidisciplinary approach to cancer management, staging allows precision in documenting disease extent. The recording of cancer stage at dx is necessary to optimize patient care and provides a valuable means for tracking patterns of disease presentation and monitoring advances in dx and therapy. The general outline for the TNM classification is given in Table 21-2. For the specific TNM classification for breast cancer, **see Sabiston 34.**

Table 21-2 (General) TNM Classification

T	(a, is, (0), 1–4): size or direct extent of the primary tumor
N	(0–3): spread to regional lymph nodes
M	(0/1): distant metastasis
Other parameters	
G	(1–4): the *grade* of the cancer cells (i.e., they are "low grade" if they appear similar to normal cells, and "high grade" if they appear poorly differentiated)
R	(0/1/2): the completeness of the operation (*resection*-boundaries free of cancer cells or not)
L	(0/1): invasion into lymphatic vessels
V	(0/1): invasion into vein
C	(1–4): a modifier of the certainty (quality) of the last mentioned parameter
Prefix modifiers	
c	Stage given by clinical examination of a patient
p	Stage given by pathologic examination of a surgical specimen
y	Stage assessed after neoadjuvant therapy

Examples of TNM language:

pT1 pN0 M0 R0 G1—Small, low-grade cancer, no metastasis, no spread to regional lymph nodes, cancer completely removed, resection material seen by pathologist; this grouping of T, N, and M would be considered stage I.

pT4 pN2 M1 R1 G3—Large, high-grade cancer, with spread to regional lymph nodes and other organs, not completely removed, seen by pathologist; this grouping of T, N, and M would be considered stage IV.

From Sobin LH, Wittekind CH (eds.): TNM Classification of Malignant Tumours, 6th ed., Wiley-Liss, 2002. Reprinted with permission of Wiley-Liss, Inc., a subsidiary of John Wiley & Sons, Inc.

Chapter 22
Teaching Visual: Breast Pathology

Ari D. Brooks MD and Paula M. Termuhlen MD

Objectives

- Describe the microscopic anatomy of the breast lobule and duct.
- Visualize cross-sectional breast pathology.
- Help your patient understand the difference between premalignant and malignant breast entities.

Medical Knowledge and Interpersonal and Communication Skills

Figure 22-1 represents a lobule and a duct, the microscopic unit of the breast. Line AB simulates a slice through the duct—to be viewed in cross-section in Figure 22-2.

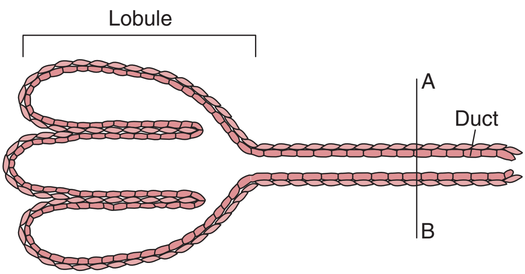
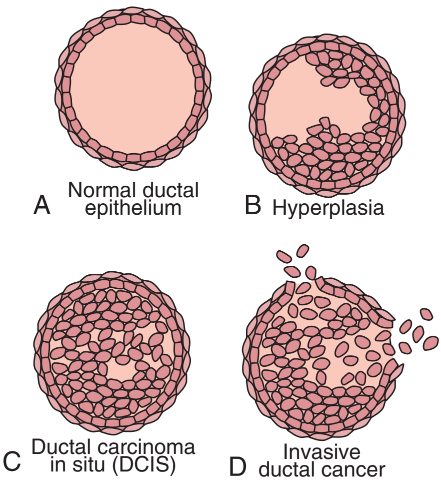


Figure 22-1

Recognizing that there are lobular cells and ductal cells, neoplastic changes can occur in either unit. For the purposes of this exercise, we are focusing on *ductal* pathology. Look at the cross-section of the duct (see Fig. 22-2). Appreciate the differences between the following entities:

- Normal ductal epithelium
- Hyperplasia
- DCIS
- Invasive ductal cancer

Figure 22-2



Note the normal orderly ductal epithelium. Note the "heaped up" appearance in hyperplasia. In *atypical* ductal hyperplasia the cells have abnormal nuclei and a disordered arrangement. In DCIS, cells fill the duct, but do not traverse the ductal membrane as seen in invasive carcinoma.

Ductal Carcinoma in Situ (DCIS)

Years ago DCIS represented less than 5% of all breast cancers diagnosed. With the advent of routine screening mammography in the United States, the incidence of DCIS has risen to over 20% of all breast cancers. The typical patient is asymptomatic and has undergone screening mammography that has identified suspicious calcifications. These pleomorphic, linear, and branching calcifications represent intraductal calcium deposits at areas of rapid cell turnover and necrosis.

Treatment options offered to women with this diagnosis include total mastectomy and lumpectomy with radiation. Lymph node sampling (sentinel node biopsy) is not routinely performed unless the area involved is considered large enough to hide an invasive cancer.

DCIS is truly a preinvasive lesion, meaning that complete removal will prevent an invasive malignancy from developing at that site. Local therapy, therefore, is the key to cure in these patients (see the description of the NSABP B-17 trial below).

In addition, the fact that a woman develops DCIS in one area of the breast indicates that she is at risk for subsequent development of breast cancer in other areas of that same breast, as well as on the contralateral side. For this reason, most patients are offered preventive therapy with tamoxifen or an aromatase inhibitor after surgical/radiation treatment has been completed.

Evidence-Based Surgery: NSABP B-17 Trial

The National Surgical Adjuvant Breast and Bowel Project B17 (NSABP B17) trial[1] randomized women with DCIS to treatment with mastectomy, lumpectomy, or lumpectomy followed by radiation therapy. The first hypothesis was that overall survival would be no different when patients were treated with mastectomy or lumpectomy. The second hypothesis was that local recurrence would be reduced when radiation was added to lumpectomy, and would be equal to mastectomy. Over 800 women were enrolled and randomized. The results were first presented with 5 years of follow-up. The first hypothesis was proven: there was no difference in survival regardless of treatment modality. The second hypothesis was also proven: lumpectomy alone for DCIS led to a 24% local recurrence rate, while radiation reduced the recurrence rate to an acceptable 8%. In addition, subsequent recurrences were less likely to be invasive cancers in the women who had received radiation therapy. This trial is the justification for our current management of DCIS. Adjuvant radiation therapy is an essential component of breast conservation.

Interpersonal and Communication Skills

Setting the Right Tone for Important Discussions

The way in which a diagnosis is initially presented to a patient sets the tone for subsequent interactions. In a case of DCIS, for example, expressing that the finding of DCIS is better than a finding of invasive breast cancer is a great place to start. Fill in the cells of the lobule and duct in Figure 22-3 to demonstrate breast microanatomy to your patient. Next, draw a line from A to B show to that you are now demonstrating the ductal cross-section.

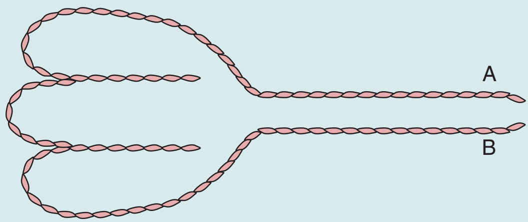
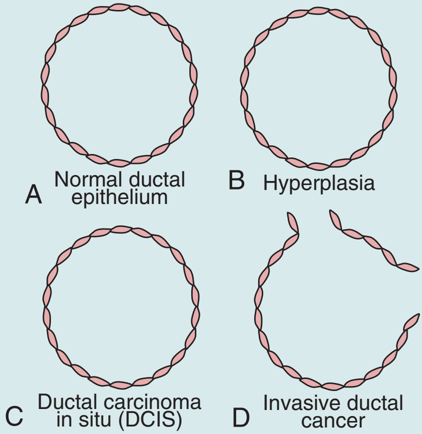


Figure 22-3

Complete the task by drawing cells in each duct in Figure 22-4 to demonstrate the normal duct, ductal hyperplasia, DCIS, and invasive cancer.

Figure 22-4



Demonstrating in your diagram that the "ductal membrane remains in tact," emphasize that DCIS is not a true invasive cancer, and, if treated appropriately, a cure will be obtained 100% of the time.

If your patient has *atypical* ductal hyperplasia on a core needle bx, use this diagram (showing the similarity of ADH and DCIS) to demonstrate why re-excision for more tissue may be necessary.

Take time to present a clear explanation of the diagnosis and to answer questions.

Interpersonal and Communication Skills

Explaining Risk

"Doctor, will I get breast cancer?" This is a very common question and for good reason. One in eight women will develop breast cancer in her lifetime. Determining which women are at high risk will help guide them through screening, affect treatment decisions, and identify women who are candidates for prevention.

To explain risk to your patient, you must first understand it yourself. Let's start with the concept of risk: If we assume that the average woman carries a risk that is equal to all other women in the population, then her relative risk is 1.0, which means she is no more or less likely than any other woman to get breast cancer. If we could identify the women who are twice as likely as other women to get breast cancer, we can say their relative risk is 2.0. If the average risk woman has a 12.5% chance of breast cancer, then a relative risk of 2.0 translates to a 25% lifetime risk—that's 1 in 4. So in breast cancer, a relative risk of 2.0 or greater is high risk.

In 1998 Gail and Rimer[2] published a large database that categorized women by a large number of variables in order to determine which variables were associated with an increased likelihood for developing breast cancer. They found the following to be risk factors:

- Increasing age.
- Having a mother or sister with breast cancer.
- Being very young at the start of menses.
- Being older than 30 at the time of first pregnancy.
- A known history of DCIS is associated with an increased risk for subsequent breast cancer.
- Having a history of breast cancer is a risk factor for the development of a new breast cancer.

A significant family history may indicate the presence of a hereditary breast cancer syndrome. The best characterized are those related to a defect in BRCA1 and BRCA2. A woman with a BRCA mutation has an 80% likelihood of developing breast cancer.

The Gail model also identified a history of many breast biopsies (benign) as a risk factor. Although a benign breast lesion such as a fibroadenoma or cyst is not premalignant, the fact that a woman makes enough of these "proliferative" lesions to warrant multiple biopsies may indicate a "proliferative" breast that is more likely to develop a cancer.

An additional benign entity that significantly increases subsequent breast cancer risk is lobular carcinoma in situ (LCIS). It is believed that LCIS does not progress to invasive lobular carcinoma, and therefore when this diagnosis is obtained at surgical biopsy, no further action is warranted for local control. LCIS is thought to be a *marker* for risk, not a *precursor* for invasive cancer. (In fact, most invasive carcinomas found in a patient known to have LCIS will prove to be invasive *ductal* carcinoma.) Women with this diagnosis are considered high risk and need close surveillance and prevention.

Treatments for the High-Risk Woman

What Are My Treatment Options If I Am "High-Risk"?

Until 1998 there were only two options for high-risk women: (1) worry a lot and (2) have a prophylactic bilateral mastectomy. The NSABP P-1 trial[3] changed that. This study randomized 13,388 high-risk women to tamoxifen or placebo for 5 years. The hypothesis was that tamoxifen use would decrease the number of breast cancers diagnosed relative to placebo. This was based on the observation that tamoxifen use after breast cancer treatment reduced new cancers compared to women who were treated for breast cancer and did not use tamoxifen. In this trial tamoxifen use reduced breast cancer incidence by 49%. Careful clinical follow-up and close surveillance with mammography, ultrasonography, and MRI, where appropriate, are still effective in this group. Bilateral prophylactic mastectomy (usually with breast reconstruction) is still a viable option that may give peace of mind to some women in this group, albeit at the risk of substantial morbidity.

References

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3. Fisher B, Costantino JP, Wickerham L, et al.: Tamoxifen for prevention of breast cancer: Report of the National Surgical Adjuvant Breast and Bowel Project P-1 study. J Natl Cancer Inst 1998; 90:1371–1388.

Chapter 23
Pigmented Skin Lesion in a 58-Year-Old Female (Case 12)

James G. Bittner IV MD and D. Scott Lind MD

Differential Diagnosis

Basal cell carcinoma	Malignant melanoma	Actinic keratosis
Squamous cell carcinoma	Atypical nevus	Benign nevus

Speaking Intelligently

When I'm asked to see a patient who presents with a pigmented skin lesion, I always begin with a thorough hx. I start by asking the patient what he or she thinks the lesion may be and reassuring the patient that as a team we will "find out" the answer. This allows me to quickly assess the patient's level of concern regarding the pigmented skin lesion. Next, I find out when the patient first noticed the lesion, if it has changed in shape, size, or color, whether or not it is painful, and if the patient has noted any similar lesions recently or in the past. I also ask about prior lesion biopsies, laboratory tests, and imaging studies ordered by other physicians prior to presentation at my clinic.

PATIENT CARE

Clinical Thinking

- Most patients think cancer first (perhaps rightfully so) and they want an answer . . . yesterday.
- Different pigmented skin lesions present differently and often atypically. Melanoma must be excluded.
- The tx of melanoma is dependent on its depth (Breslow's thickness), Clark's level (level of skin involved), and whether or not ulceration is present. Therefore, all biopsy samples of skin lesions should be full thickness to include the dermis. Shave biopsies are to be avoided.

History

Of particular interest in patients presenting with a skin lesion are the following:

- Occupation: Risk increases with prolonged ultraviolet exposure
- Geographic location: Patients who spend a significant amount of time in sunbelts around the world are at increased risk.
- Chemical carcinogens: Exposure to tar, arsenic, nitrogen mustard, soot, etc.
- Radiation: Hx of industrial, therapeutic, and occupational exposure constitutes high risk.
- Medications: Topical acne medications may predispose to skin sloughing and anticoagulants may affect surgical planning.
- Immune status: Patients with HIV, AIDS, those on immunosuppression, or individuals with repeated skin sloughing from bullous disease, decubitus ulcers, or Marjolin's ulcers all have an increased risk for developing malignant lesions.
- Previous hx of the removal of a skin lesion.
- Family hx of melanoma, atypical nevi, or pancreatic cancer.
- Hx of blistering sunburns.

Physical Examination

- The age and gender of a patient contributes to the likelihood of malignancy. Men most often have melanoma on the trunk while women have it on the lower extremities.
- Notice the skin color. Fair-skinned freckled individuals are at highest risk for skin malignancy.
- A complete skin examination in a well-lighted room includes inspection from the scalp to the toes, paying careful attention to those areas most notable for harboring cutaneous malignancies, such as the face, neck, upper back, upper and lower extremities, plus both dorsal and ventral aspects of the hands and feet.
- Document the anatomic location, size, shape, color (pigmentation), presence or absence of ulceration, blanching, bleeding, or evidence of inflammation (ABCDE of melanoma) for all skin lesions of concern.
- The findings of **A**symmetry, **B**order irregularity, variegated **C**olors, larger **D**iameter (>5 mm), or **E**rythema raise the suspicion for malignancy.
- Careful examination of the lymph node basins is crucial (cervical, supraclavicular, axillary, inguinal). Pay close attention to the path of lymphatic drainage of the skin involved and palpate for subcutaneous nodules.

Tests for Consideration

The following tests should be considered when planning biopsy of a skin lesion:

- **Punch biopsy:** A 6-mm punch biopsy is appropriate for small (<5 mm), benign-appearing lesions that will be entirely removed or for larger lesions (2 cm or more) that will require wide local excision. This test will provide a full-thickness specimen and the single most important prognostic feature—depth of invasion. **$100**
- **Excisional biopsy:** This procedure is preferred for all malignant-appearing lesions at least 5 mm in diameter where complete excision is possible. A full-thickness biopsy specimen determines depth of invasion; orient the incision in a fashion compatible with future wide local excision. **$250**

The following tests should be considered when planning a lymph node biopsy:

- **Sentinel lymph node biopsy:** An accurate, minimally invasive method of assessing the status of a lymph node basin in patients with malignant melanoma. **$1,000**
- **Lymphoscintigraphy:** A test using technetium colloid to determine lymphatic drainage of an area where drainage is ambiguous. **$650**

IMAGING CONSIDERATIONS

The following tests should be considered when working up a biopsy-proven melanoma:

➔**Chest radiography:** Evaluate for pulmonary nodules. **$75**

➔**CT:** *When melanoma depth of invasion is 4 mm or greater and/or palpable lymph nodes are present*, CT of the chest, abdomen, and pelvis with contrast is indicated; the scans stage for metastases. **$1,500**

➔**Positron emission tomography (PET):** The positron-emitting isotope of glucose is highly sensitive to melanoma. Hour-long scanning of the entire body should be purposely modified to evaluate skin and deep tissues. **$3,500**

Clinical Entities — Medical Knowledge

Basal Cell Carcinoma

Pφ **Basal cell carcinoma (BCC)** is the most common skin cancer worldwide. It is a slow-growing tumor that arises from abnormal epidermal keratinocyte growth and is divided into three types: nodular (70%–80%), superficial, and morpheaform. The histology is unique for aggregations of basophils at the tumor periphery called "peripheral palisading."

TP Nodular BCC usually presents as a waxy, raised, pearl- or cream-colored lesion with heaped borders and often exhibits central ulceration. Superficial BCC presents as an erythematous, scaling lesion usually on the trunk. BCC may also contain pigment and appear tan or black. These lesions must be differentiated from melanoma by biopsy.

Dx Most lesions can be diagnosed based on clinical presentation, but biopsy of any pigmented BCC is required to exclude melanoma.

Tx The gold-standard tx for BCC is complete surgical excision with negative margins. However, newer therapies include curettage/electrodesiccation, cryosurgery, radiation, and topical chemotherapy or immunomodulator therapy. Mohs micrographic surgery is a procedure involving successive depth shavings where each subsequent layer is evaluated under the microscope to assure a negative margin. In particular, Mohs surgery can be offered to patients with BCC size >2 cm, contiguous lesions in high-risk locations (eyelids, ears, nose), recurrent tumors, and tumors with little metastatic potential. **See Sabiston 30, Becker 65.**

Squamous Cell Carcinoma

Pφ **Squamous cell carcinoma (SCC)** is the second most common skin cancer worldwide. It arises from abnormal epidermal keratinocyte growth and is divided into two types: in situ (Bowen's disease or erythroplasia of Queyrat) or invasive. The histology demonstrates atypical squamous cells of the epidermis with possible extension into the reticular dermis.

TP Squamous cell carcinoma most often presents as a hyperkeratotic, raised, flesh-colored lesion with associated ulceration and erythema commonly located on the face, ear, trunk, or regions of skin pathology. Predisposing skin lesions for SCC include Marjolin's ulcers, decubitus ulcers, bullous disease, and areas of chronic osteomyelitis.

Dx Most lesions can be diagnosed based on clinical presentation, but biopsy of any SCC is required to exclude amelanotic melanoma.

Tx The tx for SCC is complete surgical excision with negative margins. However, newer therapies include curettage/electrodesiccation, Mohs micrographic surgery, cryosurgery, radiation, and topical chemotherapy or immunomodulator therapy. In particular, Mohs surgery can be offered to patients with SCC size >2 cm, contiguous lesions in high-risk locations (eyelids, ears, nose, lips), recurrent tumors, and tumors with little metastatic potential. **See Sabiston 30, Becker 65.**

Malignant Melanoma

Pφ **Malignant melanoma** is now the fifth most common cancer in men and seventh in women, with 54,000 new cases of invasive melanoma diagnosed and 7,600 deaths reported annually in the United States. At the time of diagnosis, about 80% present with localized disease, 15% have regional disease, and 5% have distant metastases. Melanoma arises from mutated melanocytes, and four common types are classified: superficial spreading (70%), nodular (15%–30%), lentigo (4%–15%), and acral lentiginous (5%).

TP ***Superficial spreading*** melanoma presents as a flat, pigmented lesion with variegated pigmentation, irregular borders, and areas of tumor regression anywhere on the body except the hands and feet. ***Nodular*** melanoma typically contains more pigmentation and appears raised without evidence of radial spread. The ***lentigo*** type occurs on the face, neck, and hands of elderly patients. The ***acral lentiginous*** type occurs on the palms and soles as well as the subungual region of predominantly dark-skinned people (African Americans, Asians, and Hispanics).

Dx Most lesions can be diagnosed grossly based on clinical presentation, but biopsy of every melanoma is required for type-specific identification. Breslow depth of invasion determines the T classification using the TNM system: T1 lesion <1 mm in depth; T2 lesion 1–2 mm in depth; T3 lesion 2–4 mm in depth; and T4 lesion >4 mm in depth.

Tx The tx for malignant melanoma is wide local excision with negative margins. The margin of excision is determined by the depth of the melanoma: <1 mm in depth = 1-cm margin; >1 mm = 2-cm margin. Sentinel lymph node biopsy is used for lesions >1 mm or at least Clark III. There is a questionable role for adjuvant interferon therapy in high-risk melanoma patients. Genetic testing is available and should be offered to patients who have a family hx of melanoma or pancreatic cancer or who have had multiple melanomas. **See Sabiston 30, Becker 65.**

Atypical Nevus

Pφ **Atypical nevi** are either inherited or sporadic precursors to cutaneous malignant melanoma with a prevalence of 2% to 5% in light-skinned people in the United States. The greater the number of atypical nevi present, the higher the risk for developing melanoma; however, the greatest risk is a strong family hx of atypical nevi and melanoma.

TP Atypical nevi present as large variably pigmented lesions with ill-defined borders most commonly in sun-exposed areas similar to melanoma. Ultraviolet light exposure is an independent risk factor for the development of sporadic atypical nevi.

Dx Most lesions can be diagnosed grossly based on clinical presentation, but biopsy of a melanoma precursor is required for identification. Lesions of concern should be excised with narrow margins for histologic identification.

Tx The tx for atypical nevi is excision. **See Sabiston 30, Becker 65.**

Actinic Keratosis

Pφ **Actinic keratosis** is the most common sun-related premalignant skin lesion worldwide, with prevalence directly related to ultraviolet light exposure and light skin color. Histologically, epidermal changes include acanthosis and cellular atypia of keratinocytes.

TP Actinic keratosis presents as a discrete, verrucous, hyperkeratotic lesion usually on sun-exposed areas of the face, ears, forearms, and hands. More advanced lesions form keratotic horns. Ultraviolet light exposure is an independent risk factor for the development of actinic keratosis.

Dx Most lesions can be diagnosed grossly based on clinical presentation, but biopsy of any lesions suspected of being a melanoma precursor is required for identification.

Tx The tx for advanced actinic keratosis is surgical excision. However, early small lesions may be treated initially with topical 5-fluorouracil. For smaller lesions that fail repeated attempts at medical management, cryotherapy with liquid nitrogen is an effective means of removing the cutaneous lesion. **See Sabiston 30, Becker 65.**

Benign Nevus

Pφ **Benign melanocytic nevi** represent nests of neural crest–derived melanocytes with no evidence of cytogenetic flaws or contact inhibition, which are present in most dysplastic nevi. In light-skinned individuals, benign nevi are so prevalent that they may not even be considered pathologic.

TP Benign melanocytic nevi present as small (<1 cm), well-circumscribed, uniformly pigmented, flat lesions usually on sun-exposed area. Ultraviolet light exposure is an independent risk factor for the development of benign melanocytic nevi.

Dx Most lesions can be diagnosed grossly based on clinical presentation, but biopsy of a benign melanocytic nevus is required for identification.

Tx No tx is required for these lesions. However, biopsy to r/o malignancy may be performed when the diagnosis is in question. **See Sabiston 30, Becker 65.**

ZEBRA ZONE

a. **Metastatic carcinoma to the skin:** The breast (most common), stomach, lungs, uterus, and colon are potential primary sources of cutaneous metastatic carcinoma.

b. **Keratoacanthoma:** Low-grade malignancy that pathophysiologically resembles squamous cell carcinoma. **See Sabiston 30.**

c. **Spitz nevus:** Childhood benign pigmented lesion with a rapid growth phase followed by a quiescent phase during which color changes, and pruritus and bleeding may occur. This lesion is often confused with childhood melanoma. **See Sabiston 30.**

d. **Congenital hairy nevus:** Congenital nevus with significant malignant potential. **See Sabiston 30.**

e. **Merkel cell carcinoma:** This is a rare malignancy of this neural origin cell in the dermis. It presents as a subcutaneous mass, often rapidly enlarging and locally aggressive. Surgical management is similar to that for melanoma, including wide excision and sentinel node biopsy. **See Sabiston 30, Becker 65.**

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
Technical details of intraoperative lymphatic mapping for early stage melanoma

Authors
Morton DL, Wen DR, Wong JH, Economou JS, Cagle LA, Storm FK, Foshag LJ, Cochran AJ

Reference
Archives of Surgery 1992;127(4):392–399

Problem
Although early-stage melanoma has a low incidence of positive lymph nodes, identifying these patients is important for prognosis.

Intervention
All patients with early-stage melanoma underwent a sentinel node biopsy procedure followed immediately by complete lymph node dissection to determine the accuracy of this technique.

Quality of evidence
Prospective trial of 237 patients where each patient served as his or her own control.

Outcome/effect
The sentinel node technique was accurate for the identification of positive lymph nodes and had a very low false-negative rate.

Historical significance/comments
This paper described a technique for accurately determining the pathological status of lymph nodes without a complete regional lymphadenectomy.

Interpersonal and Communication Skills

Preoperative Discussions
Preoperatively, patients are usually concerned with the overall risk of the procedure, the aesthetic results, and the likelihood of cure. I have a realistic, positive discussion addressing the risks and benefits as well as the scar and aesthetics. Postoperatively, I candidly and compassionately discuss the pathology, and the need for further evaluation if necessary. I review the prognosis and the possibility of additional surgery or tx. I review the need for sun protection and a full skin survey regularly as part of their tx and surveillance.

Professionalism

Commitment to Improving Quality of Care
When a family physician, internist, or dermatologist refers a patient with cutaneous malignant melanoma diagnosed by shave biopsy alone, the surgeon must first speak to the patient regarding the need for punch or excisional biopsy in order to fully stage the lesion. An attempt should be made by the surgeon to educate his or her colleagues regarding the appropriate diagnostic evaluation of malignant melanoma. Tactful education is the goal of professional communication. Treat and speak about colleagues respectfully, and show appreciation for their continued care of the referred patient. Encouraging local and regional family physicians, internists, and dermatologists to refer patients early will eliminate the unnecessary tests or shave biopsies that may lead to distraught, untrusting patients.

Systems-Based Practice

Public Health: Prevention
Education and prevention are the best methods to improve the care of patients at risk for skin cancer and premalignant skin lesions. Community-based education programs specifically outlining the independent risk factors of cutaneous malignancy significantly impact

the overall prevention of skin neoplasia. School-aged children and adolescents should be taught about the use of ultraviolet protection in sun-exposed areas, encouraged to minimize unprotected time in the sun during the midday, and instructed early in skin self-examination. Adults should receive similar education with particular attention to close observation of existing pigmented skin lesions. Community-based programs designed to screen individuals at risk aid in early diagnosis and may ultimately improve mortality associated withmalignant skin neoplasia.

Chapter 24
Dysphagia in a 62-Year-Old Male (Case 13)

Paul Vesco MD

Differential Diagnosis

Cerebrovascular accident (CVA)	Peptic stricture	Achalasia
Esophageal adenocarcinoma Squamous cell carcinoma	Spastic motor disorder, e.g., diffuse esophageal spasm (DES)	Zenker's diverticulum

Speaking Intelligently

When I am asked to see a 62-year-old male with dysphagia, I try to determine right away if it is oropharyngeal (upper) or esophageal (mid to lower) dysphagia. I want to know if the patient has obstructive-type symptoms or difficulty swallowing. I ask about the duration of the symptoms, change in eating habits, and weight loss. I want to know if the dysphagia began with solids and has progressed to liquids, and whether it is intermittent. I ask whether there is a hx of tobacco or alcohol use, or gastroesophageal reflux disease (GERD). Questions regarding past hx should also include recent medication changes, strokes, strokelike symptoms, neuromuscular disorders, as well as prior head or neck cancers or previous radiation therapy.

PATIENT CARE

Clinical Thinking

- Dysphagia is frequently seen in people as they age, and a careful hx should elucidate a narrow differential in 80% to 85%.
- Esophageal cancer rises with age and should always be considered in the differential dx.
- A careful hx will enable you to initiate the workup with the correct order of tests.

History

- The patient has come to you because of difficulty swallowing. Ask about any other new cognitive or motor deficits that might suggest a ***CVA***.
- A patient with obstructive type symptoms and weight loss needs an evaluation for ***esophageal carcinoma***.
- Progressive dysphagia might be due to a ***peptic stricture*** or ***carcinoma*** especially when there is a long hx of GERD.
- Intermittent dysphagia may suggest ***esophageal rings or webs*** or a spastic motility disorder such as ***DES***.

Physical Examination

- A general physical examination and focused oropharyngeal and external neck examination, including cervical and clavicular lymph nodes and the thyroid gland.
- It may be of value to observe the patient swallowing different consistencies of food.

Tests for Consideration

- **Gastroesophageal endoscopy:** Test of choice for obstructive type symptoms or GERD; provides avenue for visualization of mucosa, biopsy, or therapeutic maneuvers. **$370**, **$515 (with dilatation)**, **$670 (with biopsy)**
- **Esophageal manometry:** Measures pressure of upper and lower esophageal sphincters (UES, LES), amplitude, duration, and velocity of esophageal contractions. **$275**
- **pH probe study:** Good if patient has GERD symptoms; measures distal esophageal pH level. **$305 (24 hr)**, **$675 (48 hr)**
- **Endoscopic ultrasonography:** After a cancer dx is made, used to determine depth of invasion, possible lymph node status. **$750**

IMAGING CONSIDERATIONS

➔**Barium esophagram (barium swallow):** Initial examination. Requires minimal patient fasting. Swallowing barium liquid under fluoroscopic review. Spot x-ray images and possible cine review of surgical anatomy, mucosal lesions, and function of the esophagus. ***Barium swallow*** is cost effective and should be the first test ordered for nonobstructive dysphagia. **$370**

➔**Video fluoroscopy or cinematographic (cine) esophagram:** An examination of swallowing function rather than anatomy. Different solid and semi-solid foods are followed from oral to pharyngeal stages of swallowing. Generally used for neurologic problems and airway protection from aspiration. **$500**

Clinical Entities — Medical Knowledge

Cerebrovascular Accident

Pφ Dysphagia is documented in up to 47% of stroke patients, and up to 68% of causes of dysphagia may be related to a CVA. CVA can directly affect the cranial nerves and muscles, or lead to discoordinated action of the very complex oropharyngeal swallowing process.

TP The typical patient has other signs and symptoms of a CVA or a past hx of a CVA. In general, CVAs occur more commonly in males with hypertension, heart disease, and cigarette smoking.

Dx Barium swallow can be performed as an initial screening test. After a CVA, video fluoroscopy is the most sensitive test to document dysphagia.

Tx First, treat the CVA. A dedicated speech therapy regimen has been shown to help recover function. Dietary modifications altering consistency of foods can be helpful. Behavioral changes, e.g., chin tucking and turning the head to the side, may help prevent aspiration. **See Sabiston 72, Becker 39.**

Peptic Stricture

Pφ ***Peptic stricture*** usually occurs as the result of chronic GERD-induced esophagitis. Peptic strictures are most commonly seen at the gastroesophageal junction (GEjx) and are usually 1 to 4 cm in length. The chronic reflux causes fibrosis and scarring of the area, narrowing the lumen and leading to a progressive dysphagia.

TP The typical patient has a long-standing hx of GERD. Up to 85% of patients with peptic stricture also have a hiatal hernia. Patients with reflux and stricture are more likely to have a decreased LES pressure and decreased motility of the esophagus.

Dx Barium swallow can document the presence of a constricting lesion near the GEjx. Upper endoscopy can directly visualize the area and confirm the presence of a benign peptic stricture by endoscopic biopsy.

Tx Pneumatic dilation followed with proton pump inhibitor therapy has decreased the recurrence rate of peptic strictures. **See Sabiston 42, Becker 27.**

Esophageal Adenocarcinoma and Squamous Cell Cancer

Pφ ***Esophageal adenocarcinoma and squamous cell cancer*** are the two most frequent malignancies of the esophagus. Heavy alcohol usage increases the risk for squamous cell carcinoma by 20-fold, while smoking increases the risk 5-fold and has a synergistic effect with alcohol. Carcinogenic nitrosamines and dietary deficiencies have been implicated in the higher incidence in people from China and generally in lower socio-economic groups. Barrett's mucosa, a precursor lesion induced by chronic reflux, leads to a higher incidence of esophageal adenocarcinoma. Adenocarcinoma is generally located in the distal one third of the esophagus, while squamous cell cancer occurs most commonly in the middle third.

TP The typical patient with esophageal squamous cell carcinoma is a 60-plus-year-old male with a heavy alcohol consumption and long smoking hx. Adenocarcinoma is more prevalent in patients with chronic severe GERD.

Dx Barium swallow should be the first test ordered in any patient with dysphagia. If the patient has obstructive symptoms, upper endoscopy should be performed with brushings and biopsies of any visualized lesion. If cancer is detected, CT of the chest and abdomen and endoscopic ultrasonography should be used for clinical staging. Bronchoscopy to r/o tracheal invasion in upper and middle third lesions and PET scan may be useful preoperative adjuncts.

Tx Esophageal resection (esophagectomy) remains a crucial part of the tx of esophageal cancer. Either transthoracic or transhiatal esophagectomy provides the best option for early-stage disease. Ongoing trials have shown some benefit of neoadjuvant (preoperative) tx with chemotherapy and/or radiation therapy in stage III patients. Still, only a few patients achieve a modest and short-lived response. Radiation therapy is successful in relieving dysphagia in approximately 50% of patients. In patients with advanced esophageal cancer (who are not candidates for surgical resection), combination chemotherapy and radiotherapy can provide palliation. Laser therapy (Nd : YAG laser) and expandable metallic stents may help achieve temporary relief of dysphagia in patients with inoperable disease. Esophagectomy is infrequently used for palliation of symptoms because other tx modalities are available. **See Sabiston 41, Becker 27.**

Zenker's Diverticulum

Pφ A hypertensive UES can lead to outpouching of the cervical esophagus with regurgitation of undigested food and dysphagia.

TP Zenker's diverticula are more common in men than women and usually present in persons over 60 years of age. Affected individuals often suffer from long-standing swallowing difficulties (dysphagia), regurgitation, bad breath, weight loss, and even aspiration.

Dx Dx is made by barium swallow.

Tx The diverticulum is exposed through a lateral neck incision and is either resected (diverticulectomy) or tacked superiorly to the prevertebral fascia (diverticulopexy). Both procedures are performed in conjunction with a cricopharyngeal myotomy to prevent recurrence. **See Sabiston 41, Becker 27.**

Spastic Motor Disorder (e.g., DES)

Pφ ***Spastic motor disorders of the esophagus*** are mostly due to damage or disruption of nerves that coordinate the muscles of the esophagus. Varying abnormalities of the LES pressures and esophageal body peristalsis are present. Tertiary contractions are simultaneous, isolated, dysfunctional contractions. These contractions are nonperistaltic without known physiologic role.

DES involves spasm of the entire esophagus with intermittent dysphagia to both solids and liquids. (***Nutcracker esophagus, hypertensive LES, and nonspecific esophageal motor disorders*** are the other types of spastic motor disorders.)

TP The typical patient is in the third decade of life or older.

Dx Barium swallow should be the initial test and may show "corkscrew" esophagus with DES, but most likely will be normal or nonspecific. Upper endoscopy will r/o subtle pathology and possibly provide biopsy if warranted. Manometry is vital to differentiate the different spastic disorders. DES is characterized by simultaneous contractions in 60% of the distal esophagus with intermittent normal peristalsis and inadequate relaxation of the LES.

Tx Limited success has been reported with nitrates (nitroglycerin for acute episodes and maintenance with longer-acting isosorbide), calcium channel blockers (nifedipine, verapamil), and anticholinergics. **See Sabiston 41, Becker 27.**

Achalasia

Pφ ***Achalasia*** is characterized by failed LES relaxation, esophageal aperistalsis and atony, and esophageal dilatation. Degenerative changes of the vagus nerve and Auerbach's plexus of the esophageal muscle lead to failure to relax the LES due to unopposed smooth muscle stimulation.

TP Presentation is most often between the third and fifth decades of life without other distinguishing factors.

Dx Barium swallow may show a "bird's beak" deformity, massive dilatation of the esophagus, and tortuous path of the esophagus. Early in the disease all of these may be absent. Manometry can confirm the LES hypertension and esophageal body aperistalsis.

Tx Short-term solutions include the usage of nitrates and calcium channel blockers. Botulinum toxin injection may provide 3 to 6 months of relief. Repeat injections may not be as effective, and eventually the patient will require surgical myotomy, which is the gold standard for treating achalasia. Pneumatic dilation has been used with limited success and has higher morbidity, and its use is reserved for debilitated patients. **See Sabiston 41, Becker 27.**

ZEBRA ZONE

a. **Lower esophageal rings (Schatzki's) or webs** occur without known cause. A Schatzki's ring is a true mucosal ring located at the GEjx. Muscular rings are located 2 cm above the GEjx. Most patients are older than 40, with no sex or race predilection. Barium swallow demonstrates the ring and its location. **See Sabiston 41, Becker 27.**

b. **Leiomyoma:** A benign lesion that is located submucosally and usually asymptomatic until greater than 5 cm in size. Diagnosed with barium swallow (smooth, concave deformity) and upper endoscopy showing normal mucosa over the mass. Operation to enucleate the mass is the tx. **See Sabiston 41.**

c. **Scleroderma:** Connective tissue disorder leading to failure to adequately close the LES. Resultant reflux and poor clearance of gastric acid lead to esophagitis, fibrosis, and eventual stricture.

d. **Dysphagia lusoria:** Dysphagia secondary to external compression on the esophagus from an aberrant right subclavian artery.

Practice-Based Learning and Improvement: Morbidity and Mortality Self-Assessment Form

Complication	Cervical esophageal leak
Type	Technical error; preventable
Surgery performed	Trans-hiatal esophagectomy
Patient's disease	62-year-old man with distal esophageal cancer

Presentation	Erythema at cervical incision and clear fluid drainage on POD #4
Intervention	Opened wound, antibiotics, NPO, TPN
Outcome	Extended length of stay 1 week, now at home on regular diet with frequent dressing changes.
Risk factors	Smoker, hypertension, cachexia
How were risks addressed?	Careful assessment of viability of gastric tube after it was pulled through mediastinum into neck.
What happened?	Gastric tube likely became ischemic at the tip near the anastomosis.
What could have been done differently?	Careful tissue handling, complete mobilization of the stomach including the duodenum to avoid tension and prevent ischemia, placement of a drain in the neck.
Would outcome have been different?	Hospital course would have been shorter. A leak or fistula would have been avoided or better controlled.

Interpersonal and Communication Skills

Delivering Bad News

A 62-year-old male will understandably be upset at the news of a dx of esophageal cancer. Presenting the dx with the true facts at the outset (i.e., that overall survival of esophageal cancer is poor) can be devastating. Part of the art of medicine is to deliver bad news in stages if necessary, all the while remaining honest. Even if advanced disease is confirmed, a physician should stress that, while the disease cannot be “cured,” effective palliation can be provided for comfort and sometimes with prolongation of life.

It is easy to understand how the continual care of gravely ill patients such as those with end-stage esophageal cancer can cause a physician or surgeon to become “detached” or “desensitized.” This may be a natural reaction or self-protective coping mechanism resulting from the day-to-day interaction with very sick patients and their families. It is important, however, to remain mindful of the patient’s plight and its emotional impact on the family. Let them know you care about what they are experiencing.

Professionalism

Commitment to Honesty with Patients

Your patient asks how many esophagectomies you have done in the past year (Your answer: *one*). A body of evidence shows that high-volume surgeons in high-volume centers have lower morbidity and mortality rates. One such study showed 5% mortality in high-volume centers compared to 18% in the others. Technical ability can only decrease the risks to a certain level. Most of the perioperative morbidity is due to cardiac, respiratory, and septic complications. The better results (as compared to low-volume centers) are likely due to a team approach, during which expert surgeons work with nurses, cardiologists, pulmonologists, and radiologists who have experience and expertise in perioperative management. Be honest with your patients about these data, and be willing to recognize the limits of your experience and environment. Refer patients to another surgeon or larger center when appropriate, and don't be personally offended.

Systems-Based Practice

Standardization of Clinical Practice

Optimizing successful outcomes for common surgical procedures requires a standardized and thorough approach to preoperative evaluation, patient education as to the expected postoperative course, and standardized use of guidelines regarding such matters as antibiotic use, deep vein thrombosis prophylaxis, and perioperative analgesia. This recommended course is often referred to as a *clinical pathway*. For common operations such as laparoscopic cholecystectomy, following clinical pathways has shown excellent clinical outcomes and overall cost savings.

Chapter 25
Thyroid Nodule in a 48-Year-Old Woman (Case 14)

Mira Milas MD, Deebeanne M. Tavani DO, PhD, and Paula M. Termuhlen MD

Differential Diagnosis

Colloid nodule/cyst	Thyroid cancer	Goiter

Speaking Intelligently

When I'm referred a 48-year-old woman who presents with a thyroid nodule, I obtain an ***ultrasound*** and a ***thyroid-stimulating hormone (TSH),*** which is a biochemical marker that tells me about the patient's thyroid function.

When the TSH is normal, I obtain a fine-needle aspiration biopsy (FNA) for any thyroid nodule that is 1.0 cm or greater in diameter. ***For the patient with an elevated TSH*** (indicative of ***hypothyroidism***), I obtain an FNA and I treat the hypothyroidism.

If the TSH is abnormally low, which suggests a possible ***hyperthyroid*** state, I do not go directly to FNA of a nodule, because the nodule in question may be "hot" (an autonomously functioning nodule), in which case it is unlikely to be carcinoma. Instead, I obtain an ^{123}I uptake and scan and I attempt to correlate the nodule in question with the scan. If the nodule in question is "hot," I do not perform an FNA. I simply treat the hyperthyroidism with radioactive iodine. If, on the other hand, the hot nodule on scan and the nodule (determined by physical examination or ultrasonography) do not correlate, I obtain an ultrasound-guided FNA on any "cold" nodule >1.0 cm.

PATIENT CARE

Clinical Thinking

- The prevalence of thyroid abnormalities, especially among women, can be as high as 40%. The majority of nodules are nonpalpable and benign. Only 10% of thyroid nodules are cancerous. Incidence of malignancy increases with age.
- Findings on ultrasonography that are suspicious for malignancy include microcalcifications <2 mm, hypoechoic nodules with irregular margins, and increased intranodal vascularity.
- The only definitive dx of thyroid cancer preoperatively is by FNA.
- Thyroid FNA classifications: benign, indeterminate, malignant, nondiagnostic.
- The presence of a multinodular thyroid gland does not exclude malignancy.
- The goals of evaluating a thyroid nodule in a 48-year-old woman are to exclude the presence of thyroid cancer and to determine whether the underlying dx will require surgery. Not all thyroid nodules need to be removed.

History

- Consider the broader details of endocrine hx. Does the patient have a hx of hypo- or hyperthyroidism or previous thyroid nodules? Is there a personal or family hx of other endocrine disorders?

- Is there a hx of face or neck irradiation as a child or tx with radiation as an adult?
- Are there symptoms of obstruction (dysphagia, difficulty breathing), changes in voice, rapid growth of the lesion?
- If a patient has had a prior known hx of thyroid cancer and is now presenting with a new thyroid nodule, the details of the previous dx and tx are essential.

Physical Examination

- Examine the patient while she is sitting and facing you. The landmarks are the laryngeal cartilage and the cricoid cartilage. Just below the cricoid cartilage is the thyroid isthmus. The thyroid lobes are adjacent to the trachea.
- Ask the patient to swallow. The only structures that move in the neck during swallowing are the larynx and the thyroid gland. Observe possible movement of the nodule during swallowing.
- Palpate the neck standing in back of the patient. Gently palpate the right and left lobes of the thyroid and the isthmus, noting any enlargement, masses, or asymmetry.
- Gently bend the head to each side, attempting to palpate behind the sternocleidomastoid muscle. Palpate the supra- and subclavicular areas, the submandibular areas, and the submental area for any enlarged lymph nodes or masses.
- Have the patient demonstrate the area of concern and reexamine the patient in the position that the area of concern is best appreciated.
- Be sure to tell the patient what you find, even if the results of her examination are normal.

Tests for Consideration

Thyroid function testing:

- **Free T4:** The free or active thyroid hormone; not affected by variations in thyroid hormone binding proteins. Free T4 is the test to follow when you are treating hypo- or hyperthyroidism. **$150**
- **TSH:** TSH is an anterior pituitary glycoprotein that is regulated by hypothalamic hormones and principally by feedback of circulating thyroid hormones. Low TSH implies hyperthyroidism as TSH is being turned off by excess circulating T4. High TSH implies insufficient T4 (hypothyroid state). **$130**
- **Thyroglobulin (Tg)** is a glycoprotein that is secreted uniquely by thyroid follicular cells. The main clinical usefulness of Tg measurements is for following the status of patients with differentiated thyroid cancer who have had a thyroidectomy and remnant ablation. **$145**

IMAGING CONSIDERATIONS

➔**Neck ultrasonography:** Ultrasonography of the thyroid should use high-frequency imaging to show great detail and the size of the gland, cystic and solid nature of masses, as well as calcifications that shadow on ultrasonography. Also used for image-guided biopsy/aspiration for nonpalpable lesions. **$150**

➔**Thyroid scan:** A nuclear scan of the thyroid takes advantage of normal thyroid ability to take up radioactive iodine and provides hints at the histologic nature of nodules. "Cold" lesions are suspicious for cancer. "Hot" lesions suggest overactive thyroid cells such as adenoma. **$686**

➔**CT or MRI:** Generally not part of the thyroid imaging workup. May be needed to reveal substernal extension of the thyroid or problematic body habitus. **$1,219** **$1,794**

Clinical Entities — Medical Knowledge

Colloid Nodule/Cyst

Pφ Colloid cysts are a collection of proteinaceous material (colloid) that serves as the medium for production of thyroid hormone (thyroxine). Colloid cysts are benign and may vary in size from a few millimeters to a few centimeters. A thyroid nodule may have the predominant component of colloid that is intermixed with solid components; hence the term *colloid nodule*.

TP The typical patient is asymptomatic and may have either noticed a solitary thyroid nodule or have had the same detected on routine physical examination. A colloid cyst or nodule does not lead to symptoms of hyper- or hypothyroidism. The size of colloid cysts or nodules may fluctuate with time.

Dx Dx is made by ultrasound-guided FNA.

Tx Tx is related to the FNA dx. If benign by FNA cytology, then 6-month short-term follow-up is advisable, which should include repeat examination and repeat ultrasonography. Suppression of thyroid function is no longer a preferred tx. **See Sabiston 36, Becker 31.**

Thyroid Cancer

Pφ The spectrum of thyroid cancers includes differentiated carcinomas (***papillary*** and ***follicular*** thyroid carcinomas), undifferentiated thyroid cancers (***anaplastic*** cancers), and thyroid cancers derived from the neuroendocrine components of the thyroid (***medullary*** thyroid cancer). Thyroid cancers are not typically associated with hyperthyroidism. Prior exposure to head and neck radiation increases the likelihood that a nodule detected by physical examination or ultrasonography will be a papillary or follicular thyroid cancer. The prognosis of a thyroid cancer depends on the histologic type (Table 25-1). The unique staging system for thyroid cancers varies according to the age of the patient (see Practice-Based Learning and Improvement: Evidence-Based Surgery later in this chapter).

Dx FNA is nearly 99% accurate in giving a dx of papillary thyroid cancer. FNA is also able to diagnose medullary thyroid cancer and anaplastic thyroid cancer. Follicular neoplasms, however, cannot be discriminated by FNA, and require at least a thyroid lobectomy for dx. **See Sabiston 36, Becker 31.**

Goiter

Pφ The term *goiter* describes a thyroid gland that is enlarged focally (unilateral goiter) or globally (diffuse goiter). Goiter can also refer to the presence of a single, large nodule or multiple nodules in the thyroid, hence leading to the expressions ***uninodular*** or ***multinodular goiter***. Family hx of goiter disease and iodine deficiency are recognized etiologies of goiters.

TP The typical patient is female. The spectrum of presentation ranges from asymptomatic small goiters to large goiters that cause tracheal deviation and extend substernally. Large goiters may also manifest with hyperthyroidism, and are termed "toxic goiters." Most symptoms, when present, are due to the mass effect of a larger thyroid in the narrow space of the neck.

Dx Dx is made by physical examination, ultrasound, or incidental detection on other imaging modalities such as CT or MRI.

Tx Goiters may be observed with routine surveillance or treated by partial or total thyroidectomy. The indications for recommending surgery for goiter include the presence of compressive symptoms, the finding of atypical or malignant results on a biopsy, the presence of hyperthyroidism, hx of head and neck radiation exposure, progressive enlargement, or patient desire for improved cosmetic appearance. A total thyroidectomy should be the preferred surgical tx in the setting of bilateral thyroid abnormalities. **See Sabiston 36, Becker 31.**

Table 25-1 Thyroid Malignancy: Histologic Types

Type of Malignancy	Typical Patient	Treatment
Papillary	Papillary carcinoma is the most common histologic type; can be diagnosed by FNA. All ages. 10% can be familial. Excellent survival rate. 55% have lymph node metastasis at presentation. Subtypes: tall cell, diffuse sclerosis variant, columnar, micropapillary.	Lobectomy and isthmus or total thyroidectomy. For papillary and follicular thyroid cancers, radioactive iodine ablation of small remnants of normal thyroid tissue and microscopic thyroid cancer is performed postoperatively in high-risk patients.
Follicular	Usually in adults. Malignancy is determined by vascular invasion. Slow growing. Metastasis to bone, lung, brain.	Lobectomy for excision of nodule; if malignant by "capsular invasion," return for completion total thyroidectomy. ^{131}I used to treat metastatic disease.
Medullary	C cell derived. 20% familial or associated with other endocrine lesions. RET mutations. Prophylactic thyroidectomy may be indicated.	Total thyroidectomy and central node dissection. Evaluate for multiple endocrine neoplasia (MEN) syndromes.
Anaplastic	Older age group: the typical patient presents with a thyroid nodule that is hard on palpation. Enlarged lymph nodes may be palpable in the neck. The patient may complain of a change in voice. Anaplastic carcinoma tends to be rapidly fatal.	Total thyroidectomy to relieve symptoms of obstruction if possible. Tracheostomy to be considered at the time of initial surgery.

ZEBRA ZONE

a. **Pyramidal lobe:** superior extension of the isthmus. Can be mistaken for a separate thyroid mass. **See Sabiston 36, Becker 31.**

b. **Thyroglossal duct cyst** is a fluid-filled sac present at birth in the midline of the neck. It results from incomplete closure of a segment of the thyroglossal duct and may present as a midline cystic structure later in life. **See Sabiston 71, Becker 31.**

c. **Lymphoma of thyroid:** Usually associated with Hashimoto's thyroiditis. **See Sabiston 36, Becker 31.**

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
Management guidelines for patients with thyroid nodules and differentiated thyroid cancer

Authors
Cooper DS, Doherty GM, Haugen BR, Kloos RT, Lee SL, Mandel SJ, Mazzaferri EL, McIver B, Sherman SI, Tuttle RM

Reference
Thyroid 2006;16(2):1–34

Problem
Controversies in the dx and tx of thyroid nodules and cancer include the most cost-effective approach, the extent of surgery for small thyroid cancers, and the appropriate use of thyroxine suppression therapy.

Intervention
Meta-analysis of best evidence

Quality of evidence
Consensus statement

Outcome/effect
Eighty-four guidelines were itemized and each was graded according to the quality of evidence available on a 6-point grading scale.

Historical significance/comments
This article is a comprehensive set of guidelines by the main national and international physician group devoted to thyroid disorders.

Interpersonal and Communication Skills

Discussing Complex Issues

When I discuss thyroidectomy, I mention the dilemma of the *follicular neoplasm,* taking care to use lay terminology. This category of disease includes three different conditions: (1) *a benign hyperplastic goiter nodule,* (2) *a benign tumor,* and (3) *a malignancy*. My patient with a follicular malignancy needs to understand that the chance of having a malignancy is 20% to 30%, but the only definitive way to make a dx is thyroid lobectomy. Furthermore, it is typically not possible to determine the follicular cancer dx even during the course of surgery (as capsular invasion cannot be determined by frozen section). Therefore, if the dx of thyroid cancer is confirmed after the initial lobectomy, a patient needs to understand and be prepared for the possibility that a second surgery may be necessary to remove the remainder of the thyroid gland.

Having this type of sophisticated medical discussion with a patient, particularly those whose health literacy is diminished, I remind myself of the following steps:

1. Speak slowly and use language the patient can understand.
2. Maintain eye contact.
3. Whenever possible, draw a picture or a simple diagram.
4. Don't overwhelm the patient with more information than he or she can handle.
5. Check comprehension by having the patient repeat back important points.
6. Avoid making the patient feel ashamed. Remind your patient that many people have difficulty understanding health-care information, especially when the condition is as complex as the patient's.

In anticipation of such a discussion, have a family member or friend accompany the patient to the office visit.

Professionalism

Commitments to Improving Quality of Care and to Maintaining Appropriate Relations with Patients

I (PMT) am a thyroid cancer survivor and, therefore, I have undergone the tx that I am recommending to my patient. The challenge lies in balancing how to remain objective in recommending such tx to one's own patient, given a personal and direct knowledge of those tx. It is important to maintain focus on the individual characteristics of the patient's cancer and what the current standards of care dictate for the patient's circumstances. This scenario, rather than being a challenge, may actually add comfort and confidence to a patient's experience, as the patient comes to recognize that the physician is willing to share details of tx, expected recovery, concerns, and complications on a very direct and personal level.

Systems-Based Practice

Operations: Containing Costs through Coordination
In an uncomplicated and asymptomatic patient presenting with a solitary thyroid nodule, ultrasonography is the most cost-effective first imaging modality to use. The cost of ultrasonography includes a technical fee for performing the scan ($218) and a professional fee for interpreting the images ($468). The hospital system should be organized in such a fashion that, should a nodule be determined to require FNA, a proper FNA ($313 + pathology interpretation $562) is performed at the same visit and costs are not compounded by separate referral to a different specialist or a return trip to radiology.

Chapter 26
Hypercalcemia in a 56-Year-Old Female (Case 15)

Walter E. Pofahl II MD *and Rita El-Hajj* MD

Differential Diagnosis

Endocrine Conditions	Malignancy	Exogenous Agents
Primary hyperparathyroidism (PHPT)	Humoral Bone metastases	Thiazide diuretics Lithium Vitamin A Vitamin D

Speaking Intelligently

As a surgeon, when I am asked to see a patient with hypercalcemia, I try to determine the etiology, whether it relates to a potentially surgically correctable condition (primary hyperparathyroidism [PHPT]) and if parathyroidectomy is appropriate. PHPT and malignancy account for the vast majority of cases of hypercalcemia. Determining the etiology is usually fairly straightforward: in PHPT there is inappropriate elevation of parathyroid hormone (PTH) despite hypercalcemia; in hypercalcemia of malignancy (usually seen in advanced stage cancers), PTH is suppressed.

PATIENT CARE

Clinical Thinking

- *Primary HPT* is due to autonomous PTH secretion despite hypercalcemia. This is typically due to a benign parathyroid adenoma, but can also be caused by parathyroid gland hyperplasia.
- *Secondary HPT* is due to PTH hypersecretion in response to hypocalcemia, hyperphosphatemia, and/or vitamin D deficiency. The most common cause of secondary HPT is chronic renal insufficiency, and you will usually identify these patients easily as they are on hemodialysis. Secondary HPTH does not cause hypercalcemia. (Calcium is usually low or normal.)
- *Tertiary HPT* develops in patients with long-standing secondary HPT. In this condition, hypercalcemia occurs due to loss of physiologic regulation of PTH secretion.

History

- Hx is directed at determining etiology. Although most patients seen today with hypercalcemia are asymptomatic, it is still useful to document any of the classical symptoms ("moans, stones, and groans") related to the common target organs (CNS, renal, and bone).
- Is there a hx of malignancy or family hx of inherited endocrine disorder? (think multiple endocrine neoplasia syndromes)
- A detailed medication hx, including nonprescription medication, herbals, and vitamins, should be obtained. Symptoms of other head and neck conditions such as thyroid nodules that might require intervention should be determined.

Physical Examination

- Examination is directed at detecting neck masses that may require evaluation.
- Thyroid nodules are common.
- Palpating a parathyroid adenoma would be rare and would suggest a parathyroid cancer.
- Physical examination is also directed at detecting a metastatic malignancy that may be the cause of hypercalcemia.

Tests for Consideration

- **Electrolytes:** Confirms hypercalcemia, hypophosphatemia, and assesses renal function. **$12**
- **Albumin:** Used to calculate corrected serum calcium level $[((4 - \text{patient albumin}) \times 0.8) + \text{patient calcium}]$. **$5**
- **Intact PTH:** Confirms/refutes hypercalcemia due to HPTH. **$60**
- **Rapid PTH:** Used intraoperatively to assess change in PTH level after an adenoma is removed. The PTH should drop 50% by 5 minutes after the adenoma is excised. If it doesn't drop, the adenoma wasn't removed, or there is another adenoma present. **$165**

- **PTH-related peptide (PTHrP):** The humoral factor responsible for the majority of cases of hypercalcemia due to malignancy. $75
- **25-OH vitamin D:** Low vitamin D levels can cause secondary HPTH and can also affect intraoperative PTH responses. $25
- **24-hour urine calcium and creatinine:** This test is useful to identify patients with familial hypocalciuric hypercalcemia (FHH) $45

IMAGING CONSIDERATIONS

➔**Bone mineral densitometry:** Easily obtained scan of hip or spine with low-dose dual isotope radiation. No images. Report compares bone density to normal standards for age and sex. $275

➔**Parathyroid nuclear scan:** A nuclear medicine scan of the neck using a special radioactive imaging agent: technetium 99m **sestamibi.** Sestamibi scans may be performed in dual phase or use SPECT technology such that the imaging techniques are controversial. Thallium 201 subtraction imaging is still in use but less common. $130

➔**Neck imaging:** High-resolution ultrasonography can be helpful in detecting an adenoma; MRI, and CT are generally only used in problematic cases or instances of ectopic gland. $300–800

Clinical Entities — Medical Knowledge

Primary Hyperparathyroidism

Pφ PHPT is most often due to hypersecretion of parathyroid hormone by a solitary adenoma (>80% cases). In a smaller number of cases, HPTH is due to multigland disease.

TP Typically, HPTH is most commonly discovered on routine laboratory testing in a middle-aged female. The increased utilization of office-based laboratory testing has resulted in increased recognition of hypercalcemia due to HPTH. Most patients are asymptomatic. Overt symptoms such as lethargy, CNS manifestations, constipation, and pancreatitis are unusual.

Dx The dx of PHPT is made by the finding of inappropriate PTH elevation in conjunction with hypercalcemia. Some patients may have significant hypercalcemia, but “normal” PTH levels; in this situation, one would expect PTH to be significantly suppressed unless autonomous PTH secretion is present.

Tx Parathyroidectomy for PHPT is indicated in cases of symptomatic hypercalcemia, significant asymptomatic hypercalcemia (>0.9 mg/dL above normal), significant bone loss, or worsening renal function. If the patient does not meet the criteria for operation, calcium levels, renal function, and bone mineral densitometry should be monitored serially. If the decision is made to perform parathyroidectomy, a localizing study (sestamibi and/or ultrasonography) can often localize a solitary adenoma. In these instances, a focused exploration directed at the causative gland can be performed (eliminating the need to explore all four parathyroid glands in search of an adenoma). **See Sabiston 37, Becker 32.**

Hypercalcemia Due to Malignancy

Pφ Hypercalcemia of malignancy is a common condition that is typically due to either the presence of bone metastases or release of PTHrP by the tumor itself. Bone metastases result in local osteolysis, leading to hypercalcemia. Breast cancer, non–small cell lung cancer, and multiple myeloma are the malignancies most commonly associated with tumor hypercalcemia due to bone metastases. Secretion of PTHrP is the most common cause of hypercalcemia of malignancy (squamous cell cancers, renal cell cancer, and lymphoma) in patients without bone metastases. This protein is similar in structure and function to PTH.

TP Typically, levels of hypercalcemia tend to be higher in malignancy. Acute hypercalcemia presents with lethargy, nausea, vomiting, and bradycardia.

Dx The dx of hypercalcemia of malignancy should be suspected when hypercalcemia is present but PTH levels are low.

Tx Therapy is directed at the underlying malignancy. Tx of the hypercalcemia should be based on symptoms and degree of calcium elevation. Saline hydration should be instituted in all patients with symptomatic hypercalcemia greater than 12 to 13 mg/dL. Furosemide should be used to facilitate calciuresis in patients who cannot tolerate significant volume loading, have an inadequate decrease in calcium with volume loading, or have significantly elevated serum calcium levels (>13–14 mg/dL). A bisphosphonate to inhibit bone resorption should also be used, although peak effect will not occur for several days. Currently, calcitonin is reserved for patients not responding to the above measures. **See Sabiston 5, 37; Becker 31.**

Exogenous Agents

Pφ HPTH and malignancy account for the etiology of hypercalcemia in greater than 90% cases. Hypercalcemia as a side effect of ingested medications accounts for a small number of cases but is an important component of the differential dx. The pathophysiology varies among the different agents. Lithium decreases the sensitivity of parathyroid cells to calcium, leading to increased secretion of PTH. Thiazide diuretics decrease urinary calcium excretion. Hypervitaminosis A and D causes an increase in bone resorption. Excessive vitamin D ingestion also increases calcium absorption.

TP Dx In cases of hypercalcemia due to medications, the degree of calcium elevation is usually not high enough to cause symptoms and is discovered incidentally.

Tx Discontinuing the offending agent will lead to a prompt resolution of the hypercalcemia. **See Sabiston 5, Becker 32.**

ZEBRA ZONE

a. **Parathyroid malignancy**: Parathyroid cancer is extremely rare, but might be suspected when PTH levels are measured in the thousands.

b. **Hyperthyroidism:** Hypercalcemia may be associated with hyperthyroidism in up to 30% of cases. It tends to be mild and resolves as the hyperthyroidism is controlled. **See Sabiston 36, Becker 31.**

c. **Familial hypocalciuric hypercalcemia (FHH):** This rare disorder is inherited in an autosomal-dominant pattern. Although similar in presentation to PHPT, urinary calcium excretion is low. **See Sabiston 37, Becker 32.**

d. **Milk-alkali syndrome:** This unusual cause of hypercalcemia is due to excessive calcium carbonate ingestion.

e. **Multiple endocine neoplasia (MEN) syndromes**: Hyper-thyroidism is a component of MEN1 and MEN2A. Penetrance of HPTH in these genetic syndromes is variable.

Practice-Based Learning and Improvement: Morbidity and Mortality Self-Assessment Form	
Complication	Recurrent laryngeal nerve injury
Type	Technical error; preventable
Surgery performed	Parathyroidectomy
Patient's disease	59-year-old woman with PHPT
Presentation	Hoarse voice and mild aspiration of thin liquids
Intervention	Patient underwent medialization laryngoplasty (Teflon injection) 3 weeks after her parathyroidectomy to improve the apposition of the paralyzed vocal cord.
Outcome	Slight voice change, no further aspiration
Risk factors	None
How were risks addressed?	Meticulous dissection to identify the nerve at the tracheo-esophageal groove
What happened?	Bleeding during parathyroid gland excision led to accidental injury of the nerve due to poor visualization.
What could have been done differently?	Good exposure during bleeding is key. Visualization of the nerve as it turns toward the trachea and moves medially will indicate danger areas.
Would outcome have been different?	Avoidance of a complication very distressing to the patient and to the surgeon.

Interpersonal and Communication Skills

Abbreviations in Medical Documentation

In this chapter we have used several abbreviations: e.g., primary HPTH **(PHPT)**, parathormone-related peptide **(PTHrP).** Whereas this has been a generally acceptable means of communication, ***certain abbreviations should be avoided in medical documentation*** as they can lead to confusion and medical errors. Consider the following:

Abbreviation	Potential Problem	Preferred Terminology
U (unit)	Mistaken as 0, 4, or mL	Write the word "unit"
IU (international unit)	Mistaken as IV or 10	Write "international unit"
Q.D., Q.O.D. (Latin abbreviations for once daily and every other day)	Mistaken for each other. The period after "Q" can be mistaken for an "I" and the "O" an be mistaken for "I"	Write "daily" and "every other day"
Trailing zero (X.0 mg) Lack of leading zero (.X mg)	Decimal point is missed	Never write a zero by itself following a decimal point (X mg) and always use a zero before a decimal point (0.X mg)
MS MSO_4 $MgSO_4$	Confused for one another. Can mean morphine sulfate or magnesium sulfate	Write "morphine sulfate" or "magnesium sulfate"

Professionalism

Principle of Primacy of Patient Care: Commitment to Honesty with Patients

It is important that every surgeon track and know his or her specific outcomes. This is especially true for parathyroidectomy. As part of the informed consent process, surgeons should be prepared to discuss their personal experience (number of cases per year), cure rate (normocalcemia at 6 months), and complication rates (hypocalcemia, recurrent nerve injury) for parathyroidectomy.

Systems-Based Practice

Patient-Provider Electronic Communications
Electronic health record technology may someday allow your postoperative patients to check their own labs and follow their progress online. Evolution will also occur in patient provider communication. Electronic library ombudspeople in your office will coordinate patients' information regarding their disease(s) by showing them available Internet resources. Physicians will communicate with their patients en masse through bulletin board technology. Improvements in medications will be communicated in a focused manner to patients who are on those medications. Physicians will communicate with their patients more frequently via email. Several issues will arise. How will reimbursement for electronic communications be structured? How will HIPAA compliance be assured? While these are all legitimate concerns, your practice will not be able to escape the electronic communication revolution.

Chapter 27
Lateral Neck Mass in a 67-Year-Old Male (Case 16)

James R. Ouellette DO, *Veeraiah Siripurapu* MD, and *Bradford Davison Smith, Jr.* MD

Differential Diagnosis

Lymphadenopathy—inflammatory or infectious Viral, bacterial, fungal	Squamous cell carcinoma (SCC)	Lymphoma
Salivary gland tumors	Melanoma	Thyroid tumor

Speaking Intelligently

When asked to see a neck mass in an adult, I presume it to be neoplastic until proven otherwise. This is particularly so for middle-aged or elderly patients, especially those who have smoked. In these groups of patients it is important that the primary tumor be found quickly, preferably by use of fine-needle aspiration (FNA) without open biopsy. FNA is the standard of care. Some people like to do the FNA at presentation. I personally will image first at times so as not to "muddy the water" by creating bleeding or swelling in a lesion that is vascular or will require imaging. An appropriate referral must be made for examination of the upper aerodigestive tract with panendoscopy. Speaking intelligently with my colleagues includes my discussion of the nodal findings with reference to the correct triangle of the neck.

PATIENT CARE

Clinical Thinking

- Excisional and incisional biopsy of squamous cell cervical metastases followed by definitive tx at a *second* procedure results in a two to three times increased incidence of local recurrence when compared with dx by FNA cytology followed by definitive tx.
- 75% of lateral neck masses in patients over 40 years of age are caused by malignant tumors.
- A primary tumor of squamous cell origin can be detected in 50% of patients by clinical examination alone; an additional 10% to 15% can be detected by panendoscopy of the upper aerodigestive tract.

History

- Time line to appearance of mass.
- Tobacco and alcohol hx, radiation exposure in all patients with neck masses.
- Local (otalgia) and constitutional symptoms (fevers, night sweats, anorexia, weight loss).
- Ask about the patient's voice quality and hemoptysis. This may signify invasion of the recurrent laryngeal nerve or an endoluminal tumor.
- Malignant neck masses are more likely to be painless; pain is often associated with inflammatory adenopathy. Laterality of the mass heavily favors lymph node–related pathology.
- In the submandibular triangle and over the parotid gland, tumors or stones and infection may cause pain.
- Lymphadenopathy (benign or malignant) may be related to several entities: investigate recent intra-oral and neck infections.
- Ask about *any* existing skin lesions or those that were excised/previously treated.

Physical Examination

- Conventionally, the neck can be divided into anatomical triangles. The lymph nodes in each triangle have relatively well-defined drainage areas (Fig. 27-1).

- When evaluating a neck mass, assess size, mobility, texture, and tenderness. Evaluate the surrounding skin and surrounding lymph nodes bilaterally. Surrounding nodes may also be enlarged, but not as large as the presenting mass.
- Direct your examination to specific sites. Palpate the thyroid gland in the mid-neck. Specifically palpate the parotid gland, submandibular gland, carotid artery, and sternocleidomastoid muscle.
- Examine the oral cavity with a bright light and bimanually with a gloved finger and counter pressure from the outside. Palpate the tongue, palate (hard and soft), floor of mouth, oral mucosa, and salivary glands for masses.
- Examine the skin—observe for skin lesions or scars on the scalp, face, neck, back, chest, and abdomen. Examine the axillae and groins for additional adenopathy.
- Don't forget to examine/auscultate the chest and palpate the abdomen for masses and hepatosplenomegaly.
- The complete head and neck examination in the properly equipped office includes rhinoscopy, nasopharyngoscopy, and laryngoscopy. In some practices this may include transnasal esophagoscopy.
- Panendoscopy with directed biopsies is usually an ambulatory operative procedure with anesthesia support. Proceeding to (modified) radical neck dissection at the time of open biopsy depends on the security of the frozen section dx.

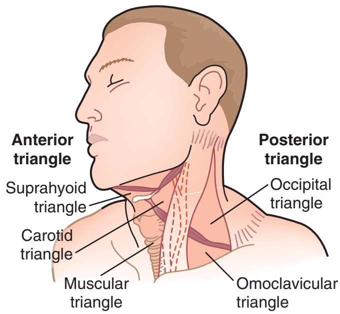

Figure 27-1 Triangles of the neck

Tests for Consideration

- **CBC:** Check for abnormal cell counts. **$30**
- **LDH:** Elevated LDH may suggest lymphoma. **$25**
- **Panendoscopy:** Refers to combined rhinoscopy, nasopharyngoscopy, inspection of the oral cavity and oropharynx, direct laryngoscopy and hypopharyngoscopy, esophagoscopy, and bronchoscopy: 3% to 12% of patients with a mucosal head and neck squamous cell cancer have a synchronous mucosal SCC. **$1,250**

TISSUE DIAGNOSIS

- **Needle biopsy:** Fine-needle (21 gauge) aspiration biopsy is preferred over large-bore (14 gauge or higher), which is usually reserved for repeated FNA failure. Slide preparation is critical for accurate dx, and necessitates review by a qualified cytopathologist. Sensitivity of 85% and a specificity of 99% are often achieved. **$250**
- **Open biopsy:** If other workup is negative. Must be prepared for formal neck dissection dependent on frozen pathology. Most series suggest that open biopsy of the metastatic node, advanced age, and increasing nodal stage have an adverse effect on survival. **$2,500**

IMAGING CONSIDERATIONS

➔**CXR:** To r/o lung lesions or mediastinal adenopathy **$135**

➔**CT of the neck with contrast:** Most reliable imaging tool of all compartments of the neck. Should be performed with IV contrast. **$225**

➔**MRI:** Excellent alternative and possibly superior imaging tool for neck pathology. Patient motion in the very old and very young is a considerable problem. However, the closer the disease is to the skull base, the more valuable MRI becomes. **$795**

➔**Ultrasonography:** Especially useful in assessing congenital and developmental cysts. Can be used for guidance of needle biopsy. **$1200**

➔**PET:** Limited value in initial dx. Excellent tool for staging and restaging head and neck malignancies, particularly with combined CT/PET techniques now available. **$1600**

Clinical Entities — Medical Knowledge

Lymphadenopathy—Inflammatory or Infectious

Pφ Cervical adenitis is a common cause of a mass in the adult neck and is usually due to inflammation or infection. Inflammatory lymphadenopathy is typically self-limited.

TP The typical patient presents with painful lymph node enlargement.

Dx Dx is generally by hx to determine suspected pathogen. *Staphylococcus* and *Streptococcus* species are the organisms most commonly cultured from neck abscesses. *Mycobacteria, toxoplasmosis,* and *cat-scratch disease (Bartonella henselae)* are less common. *HIV infection* should be considered in any adult with cervical adenopathy; recently, atypical mycobacterial infection has increased in adults who test positive for HIV. Appropriate serologic testing and a PPD test are indicated.

Infectious mononucleosis usually presents with acute pharyngitis, cervical adenopathy, and an elevated Epstein-Barr virus (EBV) titer. Dx is by Monospot/EBV titers and throat culture when mononucleosis is suspected.

Tx Nonmalignant lymphadenopathy usually requires no more than observation and antibiotics, dependent on suspected etiology. For adenopathy persisting after 2 weeks of antibiotics, fine-needle biopsy is imperative to exclude malignancy. **See Sabiston 33, Becker 51.**

Salivary Gland Tumor

Pφ ***Salivary gland tumors*** occur in the parotid, submandibular, sublingual, and minor salivary glands. A good rule of thumb is, the larger the gland, the more likely the tumor is benign. As such, 80% of parotid tumors are benign, while 80% of minor salivary gland tumors are malignant. The most common benign tumor of the parotid gland is *pleomorphic adenoma*, while the most common malignant tumor is *mucoepidermoid carcinoma,* with associated lymph node metastasis indicative of a poor prognosis.

TP A hx of a mass in the neck that may have been there for a long period of time and began growing, or the development of a new mass.

Dx Needle biopsy should be performed with CT of the neck to evaluate the tumor for extent of disease.

Tx Surgical resection of the primary tumor is the preferred tx course. In parotid tumors, either a superficial (suprafacial) or total parotidectomy may be required. The facial nerve that separates the superficial and deep lobes should only be sacrificed if the tumor is malignant and invading the nerve. If the tumor is malignant, a modified neck dissection should be considered. Radiation therapy is sometimes used postoperatively. **See Sabiston 33, Becker 51.**

Squamous Cell Carcimona

Pφ *SCC* discovered in a cervical lymph node signifies metastatic disease, likely from a primary tumor in the head and neck area. The lymphatic pattern of the head and neck is extensive and intermingled.

TP Presentation is typically a persistently enlarged node associated with either a known or unknown mass of the head, neck, oral, or nasopharyngeal areas.

Dx Complete head, neck, and oral examination associated with a needle biopsy of the lymph node usually makes the dx. In addition, CT/MRI/PET scans of the head and neck can be helpful. For the case of the unknown primary tumor, endoscopy is required (direct laryngoscopy, esophagoscopy, bronchoscopy, examination of the nasopharynx) with directed biopsy to attempt to identify the original tumor. At endoscopy, biopsies should be taken of any suspicious area detected by CT and also samples taken from the tonsils, base of tongue, and nasopharynx. Neoplasms from these sites often present with isolated neck metastasis.

Tx Tx varies depending on the primary tumor location and whether it can be found at all. When a primary tumor has not been localized and SCC has been identified, a modified radical neck dissection should be performed. If extracapsular spread is found on pathologic examination of the nodes, consideration should be given to postoperative radiation. **See Sabiston 30, 33; Becker 65.**

Melanoma

Editor's note: Primary melanoma is covered in the section on pigmented skin lesions.

Pφ When discovered as a neck mass, malignant melanoma is already metastatic to a cervical lymph node. FNA is usually diagnostic, as cytopathology will usually distinguish malignant melanoma from squamous cells and lymphocytes.

TP The typical patient may have been unaware of a primary lesion or changing mole on the head, neck, or torso, and a careful search should be made.

Dx If the primary lesion is identified, lymphoscintigraphy may be indicated to determine other lymph node basins to which the primary lesion may be metastatic. If other basins could potentially be involved (i.e., axilla, contralateral neck), a sentinel node biopsy would be indicated at the time of wide excision of the primary lesion.

Tx A modified neck dissection is indicated to remove the metastatic node along with the other cervical nodes. **See Sabiston 30, 33; Becker 65.**

Thyroid Nodules

Editor's note: Thyroid nodules are covered in detail in Chapter 25.

A metastasis from a thyroid malignancy may present as a lateral neck mass before any primary thyroid lesion is noticed. This is a commonly recognized presentation for thyroid cancer and is easily diagnosed by fine-needle biopsy. Early metastases of this type have been termed ***"lateral aberrant thyroid."*** **See Sabiston 36, Becker 31.**

ZEBRA ZONE

a. Branchial cleft cyst: Congenital epithelial cyst arising on the lateral part of the neck from failure of the branchial clefts or grooves to involute in embryonic development. In adults it may present as a smooth, nontender, fluctuant mass occurring along the lower one third of the anteromedial border of the sternocleidomastoid. **See Sabiston 71, Becker 56.**

b. Carotid body tumor: Pulsatile mass; mobile lateral medial; not supero-inferior. Confirmed by angiogram, MRA, or CT. **See Sabiston 33, Becker 39.**

c. Lung cancer presenting in the neck: Metastatic lymph node. **See Sabiston 59.**

d. Gouty tophi: Subcutaneous deposits related to gout.

e. Sarcoidosis: Granulomatous disease may present as cervical lymphadenopathy.

Practice-Based Learning and Improvement: Morbidity and Mortality Self-Assessment Form	
Complication	Aspiration pneumonia
Type	Error in judgment; probably preventable
Surgery performed	Modified radical neck dissection for melanoma metastatic to cervical lymph nodes
Patient's disease	68-year-old male with melanoma
Presentation	Witnessed aspiration immediately following extubation
Intervention	Patient required ventilatory support for 3 days.
Outcome	Patient was extubated on POD #3 and discharged from the ICU on POD #3; discharged to home on POD #5.
Risk factors	Previous CVA with swallowing discoordination
How were risks addressed?	Patient had rapid sequence induction of anesthesia.
What happened?	Patient vomited on extubation in the OR while the airway was relatively unprotected.
What could have been done differently?	An NG tube should probably have been inserted and left in until the patient was fully awake.
Would outcome have been different?	Hospitalization might have been shorter.

Interpersonal and Communication Skills

Preparing the Patient for Results

When performing a needle biopsy for any suspected malignancy, you must prepare the patient in advance for what you will do if results of the needle aspiration are inconclusive. Let your patient know your level of concern for malignancy and that you will pursue the matter further to open biopsy if the test results are "negative" or inconclusive. Should a more invasive procedure be required, the patient will understand that you have tried to make the dx with the least invasive procedure first and will understand the rationale for excisional biopsy.

Professionalism

Commitment to Scientific Knowledge
Surgeons (particularly those who practice in academic centers) frequently receive requests to provide tumor specimens for utilization in experiments related to basic science cancer research. As part of a professional commitment to the advancement of scientific knowledge, such experiments should be supported. Prior to participation, experimental protocols must be approved by the hospital's Institutional Review Board, which supervises the procedural and ethical aspects of such investigations.

Systems-Based Practice: Patient Safety

Specimen Handling
As indicated in this chapter, based on the presumed differential dx, it may be necessary to send a neck mass to pathology, cytology, microbiology, or other investigational laboratories. Critical surgical specimens should be handled by a formal chain of custody similar to critical forensic evidence, whereby each physical transfer of specimens from person to person is documented. The loss or compromise of specimens is an error that can be avoided by conscientious transfer and documentation.

Chapter 28
35-Year-Old Male with an Expanding Lump in the Thigh (Case 17)

Robin M. Ciocca DO *and Ned Z. Carp* MD

Differential Diagnosis

Lipoma	Hematoma
Soft tissue sarcoma	Sebaceous cyst

Speaking Intelligently

Dx of the common “lump” or “bump” on the extremity is usually pretty obvious. Nonetheless, I always ask myself if an extremity mass could possibly be a sarcoma. Should I be suspicious for sarcoma, my initial approach differs. Since the tx for a sarcoma of the extremity is a wide excision with clear margins (not simple enucleation of the mass), it is vital for proper planning to make the dx prior to definitive surgery. Hence the appropriate approach to a suspicious soft tissue mass of the extremity of greater than 3.0 cm is ***incisional biopsy*** or rarely core biopsy.

PATIENT CARE

Clinical Thinking

- In your career, you will encounter many “lumps” and “bumps,” but few sarcomas; nonetheless, sarcoma should be kept in your “lump” and “bump” differential dx.
- Sebaceous cysts, lipomas, and hematomas will usually be recognized by inspection and palpation. The tests and imaging studies noted below are applicable when there is suspicion for sarcoma.
- Patients will frequently present with a small mass consistent with a lipoma, which has been present for a “long time.” Excision is warranted if the lesion is tender, expanding, or of concern to the patient, or for cosmetic reasons.
- When a sarcoma is suspected, incisional biopsy (or rarely core biopsy) allows proper preoperative planning for more definitive surgical excision.

History

- How long has the mass has been present? associated symptoms of pain? limited range of motion?
- Did the appearance of the mass relate to recent trauma or skin infection?
- Has the mass changed in size or consistency since initial presentation?
- Remember to ask family hx: sarcomas may be associated with familial syndromes such as neurofibromatosis, familial adenomatous polyposis, and Li-Fraumeni syndrome.

Physical Examination

- Measure the size of the mass and document it in the chart.
- Check the mobility of the surrounding skin and subcutaneous tissues.
- Determine proximity to surrounding neurovascular structures and bony structures.
- Evaluate texture: soft fleshy subcutaneous masses are usually benign; firm hard masses are suspicious for malignancy.

Tests for Consideration

- **Biopsy:** If sarcoma is suspected, core needle or open *incisional biopsy* (rather than fine-needle biopsy) will give a sufficient amount of tissue for proper histologic examination. If sarcoma is suspected, orient the open biopsy incision in the longitudinal plane of the extremity in order not to compromise a more definitive resection, should the lesion prove malignant. — Core biopsy **$425**; Incisional biopsy **$725**
- **Incision and drainage for infected sebaceous cyst** — **$325**
- **Excision sebaceous cyst** — **$425**
- **Excision lipoma** — **$425**

IMAGING CONSIDERATIONS

➔**CT:** Performed with IV contrast in thinner sections to allow for 3-D reconstructions. Calcifications, bony integrity, and vascular supply can all be determined. **$450**

➔**MRI:** Preferred imaging tool of soft tissue pathology. MRI with gadolinium contrast is valuable to evaluate vascular structures. **$750**

➔**Angiography:** Catheter angiography is no longer used diagnostically but can provide preoperative embolization of vascular tumors. **$1,650**

Clinical Entities — Medical Knowledge

Lipoma

Pφ A lipoma is a benign soft tissue tumor of mature adipocytes.

TP Many patients have a hx of a lipoma that has been present for several years. The lesion is usually soft, mobile, subcutaneous, and nontender. When a patient states that a small mass has been present for a long time, excision is generally warranted if the lesion is tender, expanding, or of any concern to the patient.

Dx The dx of lipoma is made through hx and physical examination. Suspicious masses (e.g., firm, rapidly growing) require excision to exclude sarcoma. Incisional biopsy should be performed for larger masses greater than 3.0 cm in order to exclude the possibility of sarcoma prior to definitive surgery.

Tx Complete excision of a lipoma is usually curative. Care must be taken to excise the entire mass; a small piece left behind may regrow in the same area.

Hematoma

Pφ A hematoma is a collection of blood within a closed space.

TP Most hematomas are an acute finding in patients who have recently undergone surgery or have a hx of recent trauma. Spontaneous hematomas typically occur in patients who are anticoagulated.

Dx Dx is usually made by hx and physical examination. Ecchymosis is often present in the area. An organized hematoma may feel like a firm mass.

Tx Tx is usually observation, as most hematomas will be reabsorbed over time. Exploration is warranted if there is considerable pain, compression causing compromise of the overlying skin, or if hematomas continue to expand.

Sebaceous Cyst (Epidermal Inclusions Cyst)

Pφ A sebaceous cyst (epidermal inclusion cyst) is a subcutaneous cyst filled with sebum, formed after a sweat gland becomes blocked, but continues to secrete. These cysts commonly become infected.

TP They appear as firm, round, mobile, flesh-colored subcutaneous nodules of variable size. A central pore or "punctum" is often present, which may tether the cyst to the overlying epidermis and from which a thick cheesy material can often be expressed. Most patients will have a sebaceous cyst for a long time, but will not seek tx until the cyst expands or becomes infected.

Dx An infected sebaceous cyst will be red and tender on examination and often have a waxy, foul-smelling discharge. Noninfected cysts will present as smooth, firm, subcutaneous lesions that vary in size.

Tx Noninfected cysts should be excised with primary closure of the skin. If the "punctum" tethers the cyst to the overlying skin, a small ellipse of skin should be excised to include the "punctum." Infected cysts require incision and drainage.

Extremity Sarcoma

Pφ Sarcoma is a malignancy of the "connective tissues," which include fat, muscle, blood vessels, nerves, bones, and cartilage. There are numerous histologic subtypes of soft tissue sarcomas.

Sarcoma	Tissue of Origin	Common Presentation
Liposarcoma	Fat	Retroperitoneum
Leiomyosarcoma	Smooth muscle	Uterus, GI tract
Malignant fibrous histiocytoma	Connective tissue	Extremities and retroperitoneum
Rhabdomyosarcoma	Skeletal muscle	Arms, legs, head and neck, urinary and reproductive tracts
Synovial sarcoma	Primitive joint lining cells	Does not necessarily arise in joints; arises anywhere; appears in young adults
Angiosarcoma	Blood or lymphatic vessels	Extremities
Fibrosarcoma	Fibroblasts	Noted in scars and years after radiation therapy
Gastrointestinal stromal tumor (GIST)	Interstitial cells of Cajal	Intra-abdominal (frequently gastric) tumor
Ewing's sarcoma (peripheral neuroectodermal tumor)	Primitive cells of bone	Bone, soft tissue
Osteosarcoma (osteogenic sarcoma)	Bone	Bone
Chondrosarcoma	Cartilage	Cartilage

TP The typical patient with an extremity sarcoma has a nontender enlarging mass that may be larger than 5 cm.

Dx Tissue biopsy (as opposed to fine-needle aspiration) is critical for the dx. Core needle biopsy may be appropriate. The gold standard is incisional biopsy with attention to orient the biopsy incision so that it can be excised easily later as part of a more definitive procedure.

Tx Surgery is the cornerstone of tx for all sarcomas. The goal of resection is to excise the tumor en bloc with clear margins. Most extremity tumors are resected with limb-sparing procedures; however, if a sarcoma is recurrent or involves major vascular or nerve structures, amputation may be required. Some centers use preoperative radiation and chemotherapy to increase rates of limb salvage. Radiation therapy is used either preoperatively or postoperatively to diminish the chances of local recurrence for high-grade or large sarcomas.

The role of chemotherapy in the tx of sarcoma is limited and it is usually used only when metastatic disease is present.

Sarcomas frequently metastasize to the lung, and resection of these pulmonary metastases may improve survival in selected patients. **See Sabiston 31, 32.**

ZEBRA ZONE

a. **Desmoid tumor:** A rare benign tumor that presents as a soft tissue tumor. Occurs in the anterior abdominal wall, in areas of trauma, within surgical scars, and in patients with familial polyposis coli (FPC). Tx is wide surgical excision. Despite being characterized as "benign" (they do not metastasize), local recurrence is high if the tumor is not excised with clear margins. **See Sabiston 43.**

b. **Dermatofibrosarcoma protuberans:** Often found in an area of an old scar and can be mistaken for an infected keloid; consists of a large nodular lesion that commonly ulcerates; rarely metastasizes, but complete excision is needed to prevent local recurrence. **See Sabiston 30, Becker 65.**

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title

Prospective randomized evaluation of the role of limb-sparing surgery, radiation therapy, and adjuvant chemoimmunotherapy in the treatment of adult soft-tissue sarcomas

Authors

Rosenberg SA, Kent H, Costa J, Webber BL, Young R, Chabner B, Baker AR, Brennan MF, Chretien PB, Cohen MH, deMoss EV, Sears HF, Seipp C, Simon R

Reference

Surgery 1978;84(1):62–69

Problem

Is aggressive surgery (including amputation) for sarcoma warranted given that most patients die of metastatic disease, not local recurrence?

Intervention

Randomized patients to amputation versus limb-sparing surgery plus radiation therapy.

Quality of evidence
Prospective randomized controlled trial.

Outcome/effect
Although there was a higher local recurrence rate for limb-sparing surgery, there was no difference in survival between amputation and limb-sparing surgery.

Historical significance/comments
This study showed that thoughtful analysis of outcomes is the basis of a more reasonable surgical approach.

Interpersonal and Communication Skills

Avoiding Technical Terms
Whenever communicating with patients, be mindful to avoid technical terms you would use with your colleagues; offer explanations using clear and simple language. Here are a few suggestions I try to keep in mind when I explain issues of oncology.

Instead of saying	Say this
Inoperable	Can't be cured by an operation
Malignant	Cancerous
Metastasized	Cancer has spread
Monitor	Keep an eye on; check
Noninvasive	Without surgery or cutting skin
Oncologist	Cancer doctor
Palliative care	Will relieve pain but won't cure
Radiology	X-ray department
Referral	Send to another doctor
Toxic	Poisonous
Ventilator	Breathing machine

Professionalism

Commitment to Patient Confidentiality
Because a large percentage of extremity masses are initially suspected of being benign, the dx of sarcoma often comes as a surprise to both the patient and physician. One should never leave bad news with a family member or on a patient's answering machine. Though, at times, one cannot avoid delivering news of this type via telephone, face-to-face delivery of such information is recommended with adequate time for explanation, patient processing, and patient questions. Arrange for the patient to bring his or her significant other or another supportive family member or friend to this consultation.

Systems-Based Practice

Hospital-wide Collaboration: Physical Therapy and Rehabilitation
Soft tissue sarcoma can be a devastating experience when the surgical tx requires an amputation or a large soft tissue excision that will result in permanent disfigurement or disability. It is essential to get input from rehabilitation specialists, physical therapists, and social workers prior to definitive surgery so that the physical, emotional, and home-care needs of the patient can be thoroughly addressed. Have the patient meet with the rehabilitation team prior to surgery if amputation is anticipated. Education about prosthesis and other rehabilitation aids prior to surgery will set realistic expectations and will facilitate postoperative recovery.

Chapter 29
63-Year-Old Female with Jaundice (Case 18)

J. David Schmidt MD, James R. Oullette DO, and Giancarlo Mercogliano MD, MBA

Differential Diagnosis

Hepatocellular Causes	Extrahepatic/Obstructive Causes
Viral hepatitis	Choledocholithiasis
Alcoholic hepatitis	Cholangitis
Drug-induced hepatitis	Benign stricture
End-stage liver disease	Periampullary cancer*

*Includes pancreatic cancer, cholangiocarcinoma, ampullary carcinoma, and duodenal carcinoma.

Speaking Intelligently

When I am asked to see a 63-year-old patient who presents with jaundice, I am concerned about malignancy. Associated symptoms are helpful in differentiating between ***hepatocellular*** causes and ***obstructive*** causes. These two categories serve as a useful framework to think about conjugated (direct) hyperbilirubinemia. The tx for most hepatocellular causes is supportive, while obstructive causes are managed by intervention (either surgical or endoscopic).

I use hx taking to develop a diagnostic hypothesis and I use LFTs to corroborate it. Ultrasonography is helpful: intrahepatic bile duct dilatation will further corroborate an obstructive etiology, and other ultrasound findings will often reveal its underlying cause.

PATIENT CARE

Clinical Thinking

- Use the framework suggested above to focus hx taking.
- Use LFTs to corroborate your *hypothesis*, which should be based on *hx taking*.
- Pattern recognition for LFTs is considered below.

History

- Elicit a hx of associated *pain* (or lack of pain).
- In an elderly patient presenting with painless jaundice, think malignancy: look for weight loss and poor appetite.
- If the jaundiced patient has abdominal pain, the specifics of the pain are important: intermittent RUQ pain followed by a severe, more constant pain could represent ***choledocholithiasis*** with a stone impacted in the distal CBD. Vague RUQ pain may be the result of distention of the liver capsule associated with ***hepatitis***; chronic epigastric/RUQ pain that is boring in nature may be related to ***pancreatic cancer*** as it invades adjacent tissue.
- Past medical hx is essential: known hx of gallstones (now presenting as choledocholithiasis); previous colon cancer (now presenting with liver metastasis); or chronic pancreatitis (now presenting with stricture at the distal CBD).

Physical Examination

- Jaundice is visible as a yellow color in the skin, under the tongue, or in the sclera of the eyes. This occurs when the bilirubin level rises above 3.5 mg/dL.
- Fever: may indicate cholangitis.
- Encephalopathy or asterixis (flapping of hands with arms fully extended) point to hepatocellular/liver disease.

- Look for signs of chronic liver disease such as spider telangectasias, palmar erythema, and caput medusa.
- Abdominal examination should be thorough: assess for hepatic size and splenomegaly; look for bulging flanks seen in ascites (advanced malignancy or cirrhosis). Listen for bowel sounds. Palpate for tenderness in RUQ (cholangitis, choledocholithiasis, acute hepatitis).

Intepretation of Liver Function Tests

In general, AST and ALT are liver enzymes that can be elevated in hepatic inflammation. Prothrombin time and albumin (prothrombin and albumin are synthesized in the liver) are the true markers of liver function.

A "hepatocellular pattern" is a scenario in which the transaminases are elevated more than the bilirubin and alkaline phosphatase. This pattern is seen commonly in intrinsic liver disease such as viral hepatitis.

A "cholestatic pattern" is one in which the bilirubin and alkaline phosphatase are elevated to a greater degree than the transaminases (ALT/AST). A typical example of this pattern would be choledocholithiasis.

An AST : ALT ratio of 2 : 1 is indicative of alcoholic liver disease. See Table 29-1 for laboratory data typical for certain disorders.

Table 29-1 Typical Laboratory Numbers*

	Total Bilirubin	Alkaline Phosphatase	AST	ALT	AST : ALT
Hepatocellular Problem					
Cirrhosis	≥2		90	75	≥1
Alcoholic liver disease	1–6		200	100	2 : 1
Acute hepatitis	5	270	1,400	1,900	
Extrahepatic/Obstructive Problem					
Choledocolithiasis/ cholangitis	6	400	150	150	
Malignant CBD obstruction (pancreatic cancer)	>15	400			

*For clarity, we have chosen typical values that are representative of each condition. Those fields that are empty are either too variable to quantify, or not useful as diagnostic guides.

Tests for Consideration

- **CBC:** Leukocytosis is nonspecific, but marked elevation may suggest cholangitis; low platelets may indicate underlying cirrhosis. $30
- **LFTs:** See Table 29-1 and comment. $56

IMAGING CONSIDERATIONS

➔**Abdominal ultrasonography:** The best test for looking at gallstones and biliary dilation. Detects bile duct dilation with 95% accuracy $330

➔**CT:** Allows examination of the entire abdomen; key for assessing head of pancreas. Perform with oral and IV contrast. $520

➔**MRCP:** MRI scan noninvasively shows excellent anatomic view of bile and pancreatic ducts. $610

➔**ERCP:** Invasive test performed with a combination of endoscopy and fluoroscopy to directly examine ampulla of Vater and bile ducts. Allows intervention on biliary tree or pancreatic duct if necessary. $5,600

➔**Hepato-iminodiacetic acid (HIDA) scan:** Nuclear medicine examination showing hepatic uptake and biliary excretion; when gallbladder is visualized, the cystic duct is not obstructed. $625

Clinical Entities — Medical Knowledge

Choledocholithiasis

Pφ *Choledocholithiasis* refers to the presence of gallstones in the CBD. These stones typically originate in the gallbladder and traverse the cystic duct to enter the common bile duct. Occasionally stones may form primarily in the bile ducts, but this is difficult to prove unless the gallbladder has been removed more than 1 to 2 years previously. CBD stones found less than 2 years from cholecystectomy are assumed to be "retained" stones. Stones may bounce around the ducts, pass through the ampulla of Vater, or become lodged, causing obstruction.

TP The typical patient presents with RUQ abdominal pain associated with episodic jaundice. Intermittent obstruction may occur several times before medical attention is sought.

Dx Dx begins with the observation of jaundice followed by LFTs, which will demonstrate an obstructive pattern, and ultrasonography, which will often demonstrate dilatation of the intrahepatic ducts. Stones are frequently identified in the gallbladder, but are often not visualized in the CBD.

Tx Tx of CBD stones depends on local expertise. Most patients will need laparoscopic cholecystectomy in the near future. If cholecystectomy with laparoscopic CBD exploration can be performed with good results, this may be the tx of choice as it requires only a single procedure. In most centers, however, the practice is to perform a laparoscopic cholecystectomy with either a pre or postoperative ERCP for clearance of the CBD by endoscopic sphincterotomy with stone extraction. **See Sabiston 54, Becker 17.**

Cholangitis

Pφ ***Cholangitis*** is diagnosed when infection occurs behind a bile duct obstruction, often called acute suppurative cholangitis. The most common organisms involved are *Escherichia coli* (39%) or *Klebsiella* (54%). The obstruction most commonly results from CBD stones, but can result from stricture, tumors, or recent endoscopic manipulation. As biliary pressures increase, bacteria ascend into the biliary canaliculi, hepatic veins, and perihepatic lymphatics, leading to bacteremia and sepsis.

TP The hx may contain one or more episodes of jaundice or recent biliary manipulation (stent placement). RUQ pain, jaundice, and fever = Charcot's triad; add hypotension and mental status changes = Reynold's pentad; emergent intervention is needed.

Dx Proceed in evaluation as with choledocholithiasis, using ultrasonography to look for a dilated CBD and stones.

Tx Prior to the wide availability of ERCP, surgical intervention would have been required emergently. ERCP, available for diagnostic and therapeutic intervention, is the new standard for tx of the acute episode. Once the bile duct is drained and the patient is placed on appropriate antibiotics, a semi-elective cholecystectomy can be performed if the gallbladder is still present. If choledocholithiasis is not the cause, the reason for obstruction requires further workup. **See Sabiston 54.**

Periampullary Carcinoma

Pφ ***Periampullary carcinoma*** refers to four separate tumors with similar surgical tx: ***cholangiocarcinoma, pancreatic carcinoma, ampullary cancer, and duodenal cancer***. These tumors grow from their respective locations and can, but do not always, cause biliary and/or pancreatic duct obstruction and produce jaundice. Cholangiocarcinoma can cause obstruction in the proximal, middle, or distal CBD. The others obstruct at the ampulla. The differences lie in the 5-year survival rate, which varies greatly: duodenal (60%), ampullary (40%), cholangiocarcinoma (25%–30%), and pancreas (10%–15%).

TP Presentation is progressive jaundice associated with weakness, loss of appetite, weight loss, and no acute pain. Occasionally advanced cases result in back pain implying invasion of the celiac plexus with cure unlikely.

Dx Ultrasonography is performed, which shows biliary dilatation not related to CBD stones. This prompts CT, which may show a periampullary mass and its relation to the surrounding vasculature, which determines resectability. Metastatic disease can also be seen on CT.

Tx For resectable periampullary malignancy, the tx of choice is pancreaticoduodenectomy (Whipple procedure). This may be combined with postoperative or preoperative chemotherapy with or without radiation (best adjuvant tx is not yet defined). If there are liver metastases or the superior mesenteric artery is encased, the patient is deemed unresectable. In cholangiocarcinoma, the level of obstruction may be at a more proximal level of the bile duct. A cholangiocarcinoma at the hepatic duct bifurcation carries the eponym “Klatskin tumor.” If resectable, appropriate surgical tx is resection with a hepaticojejunostomy. **See Sabiston 54, 55; Becker 17.**

Benign Stricture

Pφ ***Benign stricture*** refers to partial obstruction without stones or malignancy. Approach any stricture of the CBD as if you suspect malignancy. There are several disease states or conditions that can result in stricture or strictures: sclerosing cholangitis (often associated with ulcerative colitis) causes multiple intermittent strictures along both intra- and extrahepatic bile ducts; previous episodes of pancreatitis may result in stricture; parasite disease or previous episodes of cholangitis may result in subsequent scarring and stricture. Postsurgical causes include CBD injury (partial transaction or cautery burn) presenting late after laparoscopic cholecystectomy.

TP Patient presents with intermittent or progressive jaundice with occasional episodes of pain. Alkaline phosphatase usually elevated.

Dx The hx is important to sort the differential. Ultrasonography is generally the first postlaboratory test. The will generally require CT and ERCP/MRCP to examine the bile ducts in greater anatomic detail.

Tx Benign strictures require an exhaustive search for a cause. Periodic stenting via ERCP may be required along with brushings or biopsy of the stricture itself. If malignancy cannot be excluded, consideration should be given to resection. A “blind Whipple” refers to a Whipple procedure performed for “suspicion” of periampullary malignancy that cannot be confirmed by preoperative testing. **See Sabiston 54.**

Cirrhosis

Pφ ***Cirrhosis*** is a medical condition resulting from hepatocyte injury and necrosis. Regardless of the etiology, fibrosis is a consequence of hepatocellular necrosis. Hepatic fibrosis exists on a continuum, and extensive fibrosis with nodule formation defines cirrhosis. Cirrhosis impacts on multiple organ systems, including gastrointestinal, hematologic, renal, cardiac, and pulmonary.

TP Jaundice related to cirrhosis is suspected based on hx of liver disease, hepatitis, heavy alcohol use, GI bleeding, and progressive symptoms with passage of time. On examination, look for evidence of temporal wasting, scleral icterus, jugular venous distention, supraclavicular adenopathy, diminished breath sounds at the lung bases, gynecomastia, spider angiomata, palmar erythema, evidence of splenomegaly, a firm liver edge, peripheral edema, and asterixis, which signify advanced liver disease.

Dx Dx of cirrhosis is based on symptoms, imaging, and liver biopsy. MRI is the best imaging test for the liver and can often identify concomitant tumor development (hepatocellular carcinoma) that may occur, especially in cirrhosis from hepatitis C.

Tx Tx depends on the stage of disease and may be limited to supportive care and counseling against alcohol use in the early stages where patients still have few sequelae. As the disease advances, tx for viral hepatitis (hepatitis B or C) may be indicated with interferon. When end-stage liver disease occurs, supportive care and tx of complications (GI bleeding, encephalopathy, hepatorenal syndrome, ascites) is indicated along with evaluation for liver transplantation. **See Sabiston 53, Becker 19.**

Hepatitis

Pφ ***Hepatitis*** can be from various causes, including viral, alcohol, medication, and others. Viral hepatitis may cause jaundice in the acute phase. Hepatitis A is transmitted by poor hygiene. Hepatitis B and C are transmitted via blood (B and C) or body fluids (B only). There is a vaccination for Hepatitis B that all health-care workers should obtain to protect from transmission. Both hepatitis B and C can lead to permanent changes in the liver and predispose patients to development of hepatocellular carcinoma and/or cirrhosis. Symptoms may be vague or short-lived and the virus may go undetected for years. Nonviral hepatitis may be caused by hepatotoxic medications, certain anesthetic drugs, or TPN. Alcoholic hepatitis occurs from alcohol-induced hepatocyte necrosis. Liver enzymes should be monitored in these cases.

TP Pain and jaundice, which generally resolve spontaneously. The chronic presentation is similar to the above description of cirrhosis or related to the development of hepatocellular carcinoma.

Dx Laboratory tests measure hepatitis C antibody, hepatitis B surface antigen and antibody, and hepatitis B core antibody. Hepatitis C virus RNA can be used as a confirmatory test for the presence of hepatitis C. For nonviral hepatitis, viral tests will be negative and other serologic markers should be used to look for other causes, such as autoimmune hepatitis.

Tx Tx depends on the etiology. Hepatitis A resolves with supportive care. Hepatitis B and C can be treated with interferon therapy, and newer antiviral medications continue to be developed. Alcoholic hepatitis requires cessation of alcohol and support. Most medication-induced hepatitis is self-limited, though fulminant hepatic failure may occur with acetaminophen overdose (most common) and may require urgent liver transplantation. **See Sabiston 52, Becker 18.**

ZEBRA ZONE

a. **Metastatic cancer:** The liver is a common site of metastasis from primary sites originating in the GI tract, lung, kidneys, and pelvic organs. Extensive tumor burden can cause hepatocellular abnormalities, and extrinsic compression of the bile duct from lymph nodes or tumor can result in biliary obstruction. **See Sabiston 52, Becker 18.**

b. **Fulminant hepatic failure:** Medications (especially acetaminophen) can cause extensive hepatic necrosis and acute liver failure, which may present as jaundice. Early identification of this condition based on hx and laboratory studies is essential. Management in a liver transplant center has become the standard of care. **See Sabiston 52, Becker 18.**

c. **Mirizzi syndrome:** CBD obstruction caused by chronic cholecystitis and large gallstones resulting in compression of the CBD. **See Becker 17.**

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title

Transection of the oesophagus for bleeding oesophageal varices. Prognostic value of Child-Turcotte criteria in medically treated cirrhotics

Authors

Pugh RN, Murray-Lyon IM, Dawson JL, Christensen E, Schlichting P, Fauerholdt L, Gluud C

Reference

British Journal of Surgery 1973;60:646

Problem

Predicting outcome in cirrhotic patients

Outcome

	Score: 1 point	**Score: 2 points**	**Score: 3 points**
Serum albumin (g/dL)	>3.5	2.8–3.5	<2.8
Serum bilirubin (mg/dL)	<2.0	2.0–3.0	>3.0
Prothrombin time (seconds over control)	<4	4–6	>6
Ascites	None	Moderate	Severe
Encephalopathy	None	Grade 1–2	Grade 3–4

Modified Child-Pugh classification.

Grade A: scores 5–6
Grade B: scores 7–9
Grade C: scores 10–15

Significance

In the early 1960s, Child and Turcotte described a means of classifying cirrhotic patients using five criteria (bilirubin, albumin, ascites, neurological disorder, and nutrition) to predict postoperative mortality following surgical portal decompression.[1]

Some 9 years later, Pugh et al. corroborated the criteria and assigned a point value for each finding, yielding the classification of cirrhosis most commonly used today.

Interpersonal and Communication Skills

Being careful not to be trapped in a conversation for which you are not prepared!

When I am called to see a patient with jaundice whose workup is in progress, I am often the first to know that the dx is one of malignancy. (Often a primary care physician will have ordered and reviewed a CT or some other diagnostic test, and I will then be asked to see the patient.) In such a situation, a consultant should be very careful when talking with the patient. I always consult the primary care team first to determine who should discuss the dx and in what setting. Before I start explaining matters to the patient, I determine what the patient knows about his or her condition. The patient's answers guide my explanation.

Medical students and residents, who are often first to evaluate a requested consultation, should be cognizant of this dilemma and should consult with attendings prior to finding themselves "trapped" in a discussion that they may not be prepared to conduct.

Professionalism

Commitment to Patient Confidentiality

You receive a call from Mrs. Jones's sister requesting information about the etiology of Mrs. Jones's obstructive jaundice. You know Mrs. Jones doesn't want her family to know about her newly diagnosed cancer of the pancreas, but you must deal with this telephone call. Deferring discussion of Mrs. Jones's condition with her sister is the correct course. You should tactfully explain that Mrs. Jones's condition is confidential and that you are obliged not to discuss her case without her permission.

The Health Insurance Portability and Accountability Act of 1996 (HIPAA), effective April 2003, protects patients' privacy of medical information. This has made patient confidentiality an even more important issue in medical practice.

Systems-Based Practice

Health Care Law: HIPAA

HIPAA requires policies and procedures to protect the privacy of medical information. This has resulted in a significant effort by health professionals and hospitals to be more diligent in protecting information from being obtained by those uninvolved in the care of the specific patient. The use of electronic medical records has raised questions about how patient information is transmitted and made available and has increased methods for monitoring HIPAA violations.

- Do not discuss cases in elevators, hallways, or dining areas.
- Do not leave computerized to-do lists in areas shared by patients and their families.
- Respond courteously and appropriately to persons requesting information.
- Do not access or share information about patients who are not under your care, including patients who are public figures, or of public or local interest.

Reference

1. Child CG III, ed.: The Liver and Portal Hypertension. Philadelphia: WB Saunders, 1964.

Chapter 30
Teaching Visual: Anatomic Relationships of the Pancreatic Head

Barry D. Mann MD, Meredith N. Osterman MD, and Paula M. Termuhlen MD

Objectives

- Describe the relationship of the CBD, pancreatic duct, ampulla of Vater and duodenum.
- Visualize cross-sectional relationships of the pancreatic head.
- Diagram for your patient how gallstones cause pancreatitis and how pancreatic tumors cause jaundice.

Medical Knowledge

In Figure 30-1, connect the green dots. Note how the distal CBD runs through the pancreatic parenchyma.

Connect the orange dots of the main pancreatic duct; note that it, too, enters the duodenum at the ampulla of Vater.

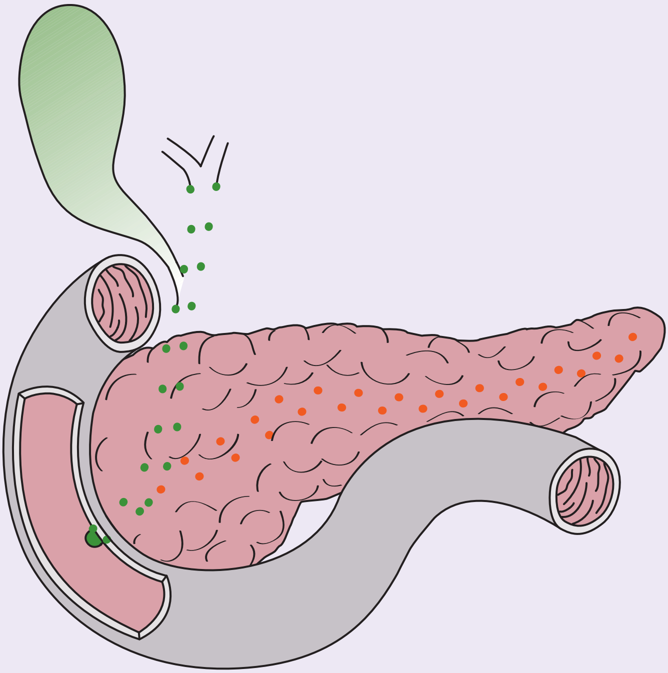

Figure 30-1

Clinical Correlates

- Small tumors of the pancreatic head may cause CBD obstruction.
- Gallstones passing through the CBD may cause pancreatitis.
- Chronic pancreatitis can cause a stricture of the distal CBD.

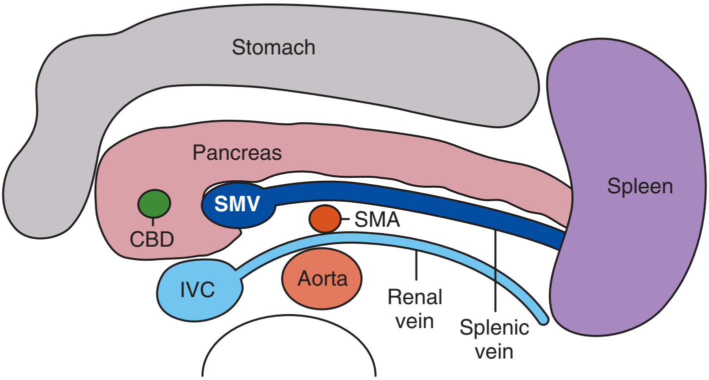

Figure 30-2

- The cross-sectional anatomy in Figure 30-2 represents an axial CT section near the inferior border of the pancreas.
- Note the circular densities—SMA, SMV, aorta, and IVC. The compressible IVC may often appear ovoid.
- The CBD, when dilated, can be seen in the pancreatic head, as depicted in Figure 30-2.
- **Note the 2 crossing veins:**
  - (1) L. renal vein crosses to the IVC between the SMA and aorta**;**
  - (2) the splenic vein runs behind the pancreas into SMV, which lies posterior to the neck of the pancreas.
- Compare with the actual CT image in Figure 30-4. (Note that the liver and kidneys are not represented in Fig. 30-2.)

Answers:
a = SMV, b = splenic v., c = SMA, d = IVC, e = aorta, f = liver, g = pancreas, h = stomach,
i = spleen, j = duodenum, k = kidneys

Now connect the dots and label the aorta, SMA, SMV, IVC, renal vein, splenic vein, and CBD. Being able to draw these cross-sectional relationships from memory will help you interpret abdominal CT scans.

Compare the anatomy depicted in Figure 30-3 and Figure 30-4. Identify *a* through *k* on the CT below. Answers are inverted on page 218.

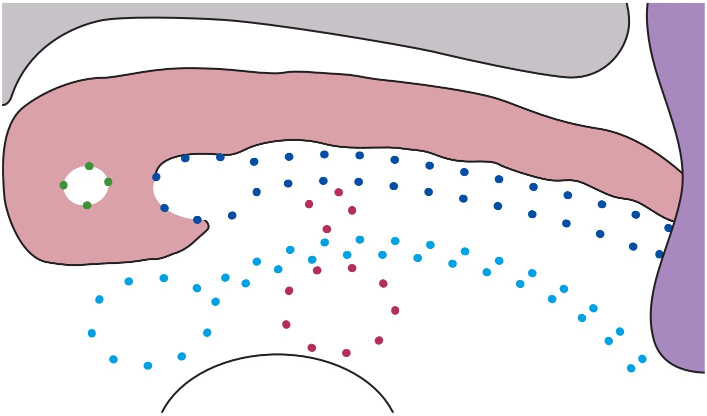

Figure 30-3 Adapted from Webb, Brant, Helms: Fundamentals of Body CT, 2nd ed. Philadelphia: WB Saunders, 1998.

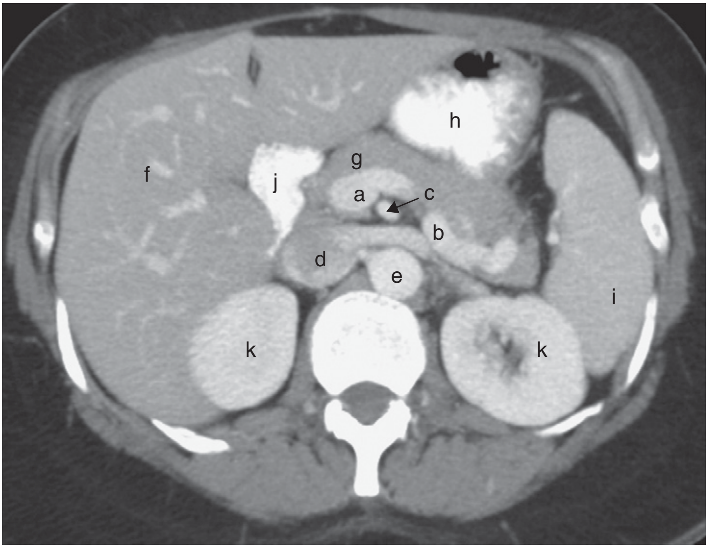

Figure 30-4 CT

Interpersonal and Communication Skills

Drawing a Diagram Can Enhance the Doctor-Patient Relationship
Using Figure 30-5, diagram for your patient how gallstones passing through or blocking the CBD may cause pancreatitis.

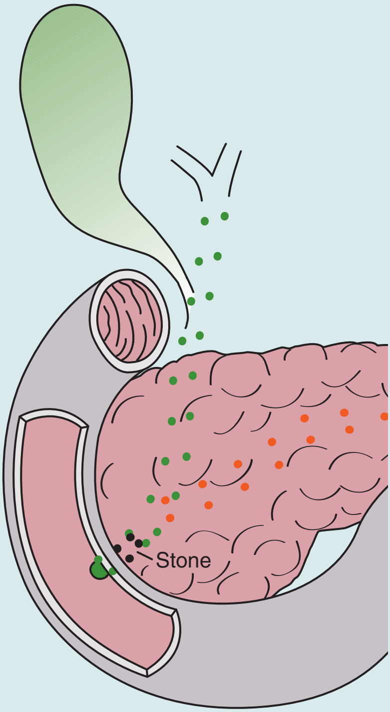

Figure 30-5

When I draw an obstructing stone for a patient, it's usually in the context of explaining why an ERCP is indicated. I generally draw an endoscope in duodenum and explain how the sphincter is cut (sphincterotomy) and how the stone is "fished out." I always emphasize that this will be done under sedation. The drawing helps clarify why pancreatitis is a potential complication of the procedure. I then draw a few stones in the gallbladder to demonstrate why a laparoscopic cholecystectomy is necessary following ductal clearance, lest another stone fall into the common bile duct.

Using Figure 30-6, diagram for your patient how a small tumor of the pancreatic head causes common duct obstruction and jaundice.

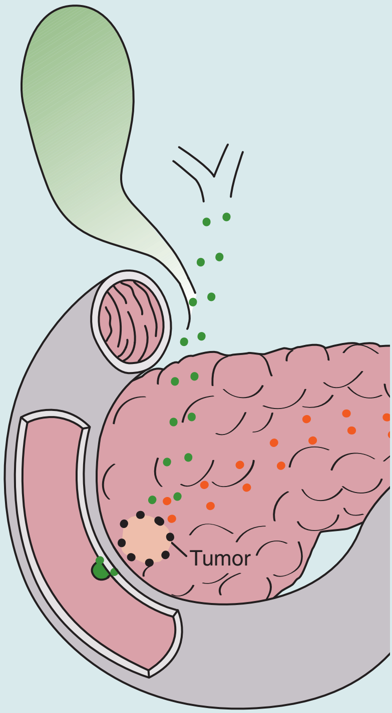

Figure 30-6

Discussing the potential risks and benefits of a Whipple procedure can be overwhelming for the patient with pancreatic cancer. Using a drawing such as above, emphasize the positives: “We wouldn’t be recommending such a procedure if the preoperative data didn’t suggest that the tumor is resectable.” I use such a diagram to illustrate the need to remove the head of the pancreas, the duodenum, and the intrapancreatic CBD. If a patient is curious enough to ask about the reconstruction, I draw Roux-en-Y reconstruction, demonstrating choledocho-jejunostomy, pancreatico-jejunostomy, and gastro-jejunostomy. (See Teaching Visual: the Roux-en-Y limb, Chapter 56.)

Chapter 31
Splenomegaly in a 40-Year-Old Female (Case 19)

Matthew I. Goldblatt MD *and Clifford H. Pemberton* MD

Differential Diagnosis

Portal hypertension	Lymphoproliferative disorders: Leukemia Lymphoma	Myeloproliferative disorders: Myelofibrosis Polycythemia vera (pVera) Essential thrombocythemia (ET) Chronic myelogenous leukemia (CML)
Infectious mononucleosis	Blood dyscrasias: Spherocytosis Sickle cell disease	Benign masses: Abscess Cysts

Speaking Intelligently

When I am asked to see a patient with splenomegaly, I start by asking how the abnormality was detected. In most cases, it is a finding on abdominal CT. I then focus on associated symptoms such as fevers, chills, night sweats, weight loss or gain, nausea, early satiety, and abdominal pain. I explore past medical hx, including family hx, sexual hx, foreign travel, and alcohol use. I then proceed with an examination estimating the sizes of the liver and spleen, and looking for signs of lymphadenopathy, jaundice, and other stigmata of portal hypertension.

PATIENT CARE

Clinical Thinking

- The proper workup for splenomegaly will delineate whether it is directly related to the spleen or if the splenic enlargement is secondary to an underlying disease process.
- Realize that most patients do not even know where their spleen is, nor do they know anything about its function. When evaluating a patient with splenomegaly, anticipate that a significant amount of patient education will be required.

- The patient undergoing splenectomy will be at risk for future infection. The most common organisms that cause infections/sepsis after splenectomy are *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Neisseria meningitis*. If possible, *H. influenzae* type B, meningococcal, and pneumococcal vaccines should be administered 2 weeks prior to splenectomy; otherwise, vaccination 2 weeks following surgery is acceptable. As the risk for post-splenectomy sepsis is highest in the first year after surgery, patients must be advised to be cautious when dealing with any minor infection or illness.

History

- Why were you asked to see the patient? Was the enlarged spleen noted because of "B" symptoms (fevers, chills, night sweats), pain, or early satiety, or is splenomegaly an incidental finding? If splenomegaly is an incidental finding on a CT of the abdomen, what was the indication for the test?
- Review of systems should include a hx of trauma, abdominal pain, foreign travel, easy bruising or bleeding, weight loss or gain, and sexual hx.
- Alcohol abuse or a hx of hepatitis may point toward cirrhosis and portal hypertension.

Physical Examination

- Normally the spleen rests under the tenth and eleventh rib on the left. The average spleen is 12 cm by 7 cm. It needs to be substantially larger than that to be palpated by most clinicians.
- A thorough abdominal examination with gentle but deep palpation is performed. A palpable mass in the left upper or lower quadrant of the abdomen should be suspicious for the spleen. When suspecting splenomegaly, begin palpating low in the abdomen, lest the tip of a massive spleen be missed.
- Examine for lymphadenopathy.

Tests for Consideration

- **CBC** is a critically important test in the workup of splenomegaly. This should be accompanied by an examination of the peripheral smear. Abnormal cell morphology would suggest an underlying blood disorder and may be diagnostic. **$80**
- **LFTs with LDH:** These tests will identify liver disease and indicate possible portal hypertension as the etiology; an isolated LDH elevation may indicate lymphoma. **$75**

IMAGING CONSIDERATIONS

➔**CT of abdomen and pelvis:** Perform with oral and IV contrast. Imaging tool of choice.	$800
➔**Ultrasonography of abdomen:** Generally not an initial imaging tool. Color Doppler can provide vascular flow characteristics of portal and splenic veins.	$250
➔**MRI of abdomen:** Generally unnecessary but does have applications for MR arteriography/venography.	$1,500
➔**PET scan:** No value in initial diagnostic workup. Very valuable in lymphoma treatment and staging.	$2,500

Clinical Entities — Medical Knowledge

Infectious Mononucleosis

Pφ Infectious mononucleosis is a viral disease (Epstein-Barr virus) that is spread from human to human by close physical contact. The inflammatory response and increased circulating blood monocytes can lead to splenic engorgement.

TP The typical patient will have an incubation period where only a sore throat is present. As the illness progresses, the patient may develop fever, malaise, and myalgias. Eventually splenic enlargement may lead to early satiety and/or LUQ pain due to stretching of the splenic capsule.

Dx Dx is made by the heterophile test or Monospot test.

Tx The disease is usually self-limiting. The most concerning problem relating to the spleen is spontaneous splenic rupture (0.5% of cases). Adolescents with mononucleosis should be advised to avoid vigorous physical activity and contact sports. If splenic rupture occurs, urgent splenectomy is the tx.

Benign Splenic Mass: Splenic Abscess

Pφ Most splenic abscesses arise from the hematogenous spread of infection from distant sites. Other causes include infection of an area of devitalized spleen from infarction or splenic hematoma from trauma.

TP The typical patient will present with signs and symptoms of infection. Fatigue, abdominal pain, fever, elevated WBC count.

Dx CT of the abdomen is performed if symptoms point to an intra-abdominal source for the infection. CT will show a nonenhancing fluid collection within the spleen that may even contain gas.

Tx Broad-spectrum antibiotics that cover *Staphylococcus* and *Streptococcus* species as well as gram-negative organisms should be used. Percutaneous drainage of the abscess can be obtained with the known complication of significant hemorrhage. If percutaneous techniques are not adequate, then splenectomy is warranted. **See Sabiston 56, Becker 20.**

Benign Splenic Mass: Splenic Cysts

Pφ There are three types of splenic cysts: (1) nonparasitic cysts, which are epidermoid cysts; (2) parasitic cysts, rare in the United States (look for a hx of foreign travel; the most common cause is *Echinococcus granulosus*); and (3) pseudocysts, which arise after trauma related to splenic hematoma or fracture.

TP Typically these patients present with the typical symptoms of an enlarged spleen (i.e., LUQ pain, nausea, and early satiety). Parasitic cysts may also show signs and symptoms of liver disease, since the cysts are also commonly found within the liver.

Dx Dx is by CT of the abdomen. Nonparasitic cysts are solitary and unilocular with an enhancing wall. Parasitic cysts have wall calcifications and possibly internal daughter cysts. Pseudocysts tend to be unilocular with a nonenhancing wall.

Tx Tx for nonparasitic cysts and pseudocysts would be splenectomy, if symptomatic. For parasitic cysts, splenectomy is important to avoid spontaneous rupture and spread of the parasites throughout the abdomen. **See Sabiston 56, Becker 20.**

Portal Hypertension

Pφ Splenomegaly from portal hypertension arises from congestion secondary to elevated venous pressure in the short gastric and splenic veins.

TP These patients present with other signs of portal hypertension, including ascites, variceal bleeding, and upper abdominal or LUQ pain. In addition, these patients may have thrombocytopenia related to hypersplenism.

Dx Physical examination may show jaundice, fluid related to ascites, gynecomastia, palmar erythema, and caput medusae. Enlarged palpable spleen with hepatomegaly may also be noted. CT may demonstrate venous collaterals (varices) to the esophagus and colon.

Tx Splenectomy is rarely indicated. Tx should focus on the underlying cause of the portal hypertension. If the patient suffers from bleeding varices from splenic vein thrombosis without liver disease (sinestral hypertension), then splenectomy is curative. **See Sabiston 53, Becker 19.**

Lymphoproliferative Disorders: Leukemia/Lymphoma

Pφ The leukemia subtypes that are associated with splenomegaly are chronic lymphocytic leukemia (CLL) and hairy cell leukemia (HCL). Sequestration of platelets and leukocytes in the liver contribute to the splenomegaly.

TP The typical patient will present with fatigue, weight loss, and early satiety. A lymphoma patient may also have lymphadenopathy, nausea, fevers, chills, sweats. Abnormal cells may be noted on peripheral blood smear.

Dx CT will confirm an enlarged spleen. CBC and a bone marrow biopsy are used to confirm the dx of leukemia.

Tx In patients with CLL, splenectomy can help boost the platelet count, but does not affect the outcome of the leukemia itself. Splenectomy for HCL is reserved for those patients who are symptomatic and not responsive to chemotherapy. Splenectomy may be required for diagnostic purposes in lymphoma, when the spleen is the only site of lymphatic involvement. Tx of the lymphoma with chemotherapy and/or radiation reduces the enlarged spleen in most cases. **See Sabiston 56, Becker 20.**

Blood Dyscrasia: Sickle Cell Disease

Pφ Sickle cell disease is caused by a single amino acid substitution in the beta chain of hemoglobin. This causes a change in the shape of RBCs during hypoxia. This can lead to sequestration of the RBCs within the spleen. Splenic infarction makes splenomegaly uncommon in this population.

TP Sickle cell disease occurs largely in the black population. A sickle cell crisis can occur with shortness of breath, chest pain, bone pain, or hematuria.

Dx Dx is by electrophoresis to identify the S form of hemoglobin. Dx of a splenic sequestration crisis can be by physical examination, ultrasonography, or CT to determine the size of the spleen.

Tx When a patient has had a major sequestration crisis, this is generally sufficient reason to perform a splenectomy. There is a greater than 40% chance of another attack with a mortality rate as high as 20%. **See Sabiston 56, Becker 20.**

Blood Dyscrasia: Spherocytosis

Pφ Hereditary spherocytosis is caused by defects in the proteins within the RBC membrane that cause the blood cell to be spherical and less deformable. This leads to RBC sequestration and destruction within the spleen.

TP Many patients are asymptomatic. Symptomatic patients may have anemia, jaundice, and/or splenomegaly, which causes LUQ pain.

Dx Dx is through a peripheral blood smear. Spherocytes will be seen. These can also be seen in autoimmune hemolytic anemias, but in spherocytosis, a Coomb's test is negative. An osmotic fragility test can be performed to confirm the dx.

Tx Tx for spherocytosis is splenectomy. Waiting until at least 4 years of age helps decrease the incidence of post-splenectomy sepsis. A cholecystectomy may also be required since many patients have pigment stones from the constant turnover and breakdown of hemoglobin. **See Sabiston 56, Becker 20.**

Myeloproliferative Disorders (Myelofibrosis, pVera, ET, CML)

Pφ Patients with myeloproliferative disorders often have splenomegaly. Splenic enlargement is due to both extramedullary hematopoiesis and sequestration of circulating blood elements.

TP Most patients with splenomegaly related to these disorders are asymptomatic. Pain and early satiety are infrequently seen. Thrombocytopenia may be seen here as well.

Dx CT makes the dx of splenomegaly; a low platelet count indicates secondary hypersplenism.

Tx In selected symptomatic patients a splenectomy may be helpful. **See Sabiston 56, Becker 20.**

ZEBRA ZONE

a. **Severe congestive heart failure:** Congestive heart failure more commonly produces hepatic enlargement. Splenomegaly would be unusual as the only presenting sign.

b. **Sarcoidosis:** A granulomatous disease that can involve almost any organ including lymphatic organs. Splenomegaly occurs in 10% of patients with sarcoidosis.

c. **Gaucher's disease:** Lysosomal storage disorder. Accumulation of Gaucher cells (glucocerebroside-laden macrophages) within the spleen.

d. **Malaria:** Also known as a tropical splenomegaly or hyperreactive malarial splenomegaly. The symptoms are LUQ pain, nausea, and a mass. Tx with antimalarial drugs is usually effective.

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
Polyvalent pneumococcal-polysaccharide immunization of patients with sickle-cell anemia and patients with splenectomy

Authors
Ammann A, Addiego J, Wara D, Lubin B, Smith W, Mentzer W

Reference
New England Journal of Medicine 1977;297(17):897–900

Problem
Patients have increased susceptibility to encapsulated bacterial infections post-splenectomy.

Intervention
Patients who underwent splenectomy or were asplenic due to sickle cell anemia were prospectively immunized against *Pneumococcus*.

Quality of evidence
Prospective case-controlled trial (96 patients, 82 controls)

Outcome/effect
There were no pneumococcal infections in the treated group over 2 years, while there was a 7% incidence among age-matched healthy controls.

Historical significance/comments
This was the first study to indicate the utility of vaccination to prevent pneumococcal infection post-splenectomy.

Interpersonal and Communication Skills

Important Discussions

Because the risk for post-splenectomy sepsis is highest in the first year after surgery, patients must be advised to be cautious when dealing with any minor infection or illness. This discussion regarding post-splenectomy sepsis should not be glossed over, and it should not take place when the patient is overwhelmed hearing other details about planned surgery and postoperative course. This is an ideal time to:

- Plan a separate patient encounter.
- Educate and advise the patient preliminarily and let him or her know that you will be covering the issue again in the next meeting.
- Convey concern that this matter requires the patient's close and ongoing attention in the future.

Professionalism

Commitments to Improving Quality of Care, to Professional Competence, and to Scientific Knowledge

Patients who have splenomegaly and associated thrombocytopenia from splenic sequestration of platelets usually do not have bleeding issues at time of presentation. Preoperative platelet transfusion is a very common error made by physicians who are treating the "platelet count." Platelets that are transfused preoperatively are merely sequestered by the spleen. Hence, there is no benefit of preoperative transfusion. Once the splenic vessels have been ligated (during surgery), then platelet transfusion may be appropriately initiated in order to decrease the risk for postoperative bleeding complications. Understanding this physiology is important. Platelets are a pooled blood product from multiple donors, and unnecessary exposure for the patient should be avoided when possible.

Systems-Based Practice

Cost Drivers: Drugs

Your patient with CML and splenomegaly has just purchased the new immunosuppressive drug you prescribed (Omnishrink) and jokes with you about whether it's supposed to shrink his spleen or his wallet. Indeed, there is much controversy over the cost of drugs, and with good reason: Many new drugs on the market are surprisingly expensive, considering that it only costs a fraction of their price to actually manufacture them. The reason for this (the pharmaceutical industry argues) is the enormously high cost of developing new drugs. The typical pharmaceutical company has to start research on 200 novel compounds in order to bring a single drug to market. When that drug reaches market, the company needs to earn back the cost of developing the 199 other drugs that didn't come to fruition.

To help protect profits, the government enforces a 20-year patent on new drugs: during this time only the drug's developer may produce and sell the new drug. In reality, by the time a drug gets to market, usually only 10 to 12 years of the patent are left. Once this period ends, however, other drug manufacturers can make the same drug and sell it as a *generic* for significantly less, which they are able to do because they do not need to cover the development and marketing costs of the drug. While many new drugs are worth the high cost, most hospitals have *formularies* in place that require generics to be used whenever possible.

If you have had the opportunity to evaluate a patient with a malignancy, you are encouraged to review your patient's course in the context of the Competency Self-Assessment Form on page 35. The form can also be found as a Word document on the book's Web site on www.studentconsult.com, from which it can be printed or downloaded. When considering competency self-assessment in the cancer patient, pay particular attention to how the quality of multidisciplinary cancer care may have been affected by interpersonal skills, communication among consultants, and decision making based on evidence-based medicine.

Professor's Pearls: Surgical Oncology

Section Review

Consider the following clinical problems and questions posed. Then refer to the professor's discussion of these issues.

1) A 40-year-old female has a 3-month hx of weight loss and early satiety. She recently developed chills, night sweats, and a rash. What are your diagnostic considerations?

2) A 38-year-old female has a palpable right breast mass found by her primary care physician in the upper outer quadrant on her annual physical examination. The mass is irregular, firm, and fixed. She has no pain or tenderness. Her mother and two maternal aunts died of breast cancer. The patient had a breast biopsy 10 years ago on the same side for "something that was not cancer." How would you treat this patient?

3) A 57-year-old female is noted to have persistent hypercalcemia (12.5 g/dL) due to primary hyperparathyroidism. She has no comorbidities. Parathyroidectomy has been recommended. How should she be evaluated?

4) A 64-year-old white male farmer presents with an asymptomatic, pigmented upper back lesion that has increased in size and changed color since his wife initially recognized it 2 years ago. Physical examination is significant for a single small, raised, and variably pigmented upper back lesion with irregular borders. Labs demonstrate normal WBC count, hemoglobin, and coagulation studies. Chest radiography reveals cardiomegaly and pulmonary hyperinflation without evidence of pulmonary nodules. How would you proceed in your evaluation?

5) A 72-year-old woman is sent by her primary care physician with a dx of breast abscess. She has no hx of prior breast problems, no abnormal mammograms, and no family hx of breast cancer. She reports that a mass appeared 2 weeks ago and has become inflamed and tender, and a course of antibiotics prescribed by her physician has not helped the situation. On physical examination, the breast is tender and erythematous in the upper inner quadrant, with nondiscrete fullness in the area.

6) A 62-year-old male with long-standing GERD presents with dysphagia. His symptoms have been poorly controlled with intermittent proton pump inhibitor usage. He has trouble with solids and occasionally with liquids. What are the diagnostic considerations and how would you proceed?

7) A 48-year-old woman had a CT of the chest during evaluation for pneumonia. The radiologist made a comment about the irregular appearance of the right lobe of the thyroid gland. The patient has noticed some difficulty swallowing and a sense of pressure when she bends her neck over the past year. She cannot detect any neck abnormalities on self-examination, and physical examination by her internist also shows no palpable thyroid irregularities. The patient is sent for evaluation. How would you proceed?

8) A 21-year-old male college student presents with a right neck mass of 1 month's duration. He reports that the mass is stable in size and nontender. He reports fatigue but no fevers, chills, or night sweats. Physical examination reveals an isolated level 2 lymph node, firm, nontender, and mobile, measuring about 1.5 cm. What are the likely diagnoses? What tests would you perform?

9) A 50-year-old male presents with progressive swelling in his calf over the past year. Physical examination reveals a significant size discrepancy between right and left lower legs, and a fullness in the calf muscles. The patient denies pain, hx of trauma, heart disease, vascular disease, or prior malignancy. How would you evaluate this problem?

Discussion by Ari D. Brooks, MD, Associate Professor of Surgery, Drexel University College of Medicine, Philadelphia, Pennsylvania

Answer 1

I am always suspicious of unintentional weight loss and early satiety. Add to that some classic B symptoms, including night sweats, chills, and a rash, and you are now looking at a lymphoma until proven otherwise. This patient will likely have lymphadenopathy in some accessible area such as the axilla, neck, or groin, but CT of the chest, abdomen, and pelvis will help identify the extent of disease. Many patients with lymphoma will have an enlarged spleen, but this is neither the source nor the major problem affecting this patient. A CBC and a lymph node biopsy are indicated to make the dx, and this patient will move on to chemotherapy with or without radiation.

At times I will be contacted later in the course of therapy to perform a splenectomy for control of pain or to improve nutritional status. In patients who are going on to bone marrow transplantation, a splenectomy may help prevent thrombocytopenia and remove residual disease.

Answer 2
This patient is high risk for cancer by family hx alone. Now, with a nontender and suspicious mass found on routine physical examination, it looks like we have found a cancer. I try to have mammography and ultrasonography done before my first office visit. Anxiety runs high in this disease, and tends to have an inverse relationship to age. My intention is to make a dx as rapidly as possible. After a careful hx and complete physical examination with attention to risks for bleeding, I perform an ultrasound-guided biopsy on the first visit. The patient's experience with breast cancer is quite bad, with a 100% mortality rate in her family. My intention is to establish that this is truly early-stage disease, and that we caught it in time. With a positive biopsy result, I will schedule surgery (usually lumpectomy and sentinel node) quickly, and order an extent of disease workup. In the majority of cases, even with a palpable breast mass, the patient is still in stage I or II, and our discussion will focus on the excellent survival in these groups with adequate multidisciplinary management. Sometimes a mastectomy is required, if the tumor is very large, multicentric, or associated with diffuse ductal carcinoma in situ. Sometimes, a mastectomy is a good option, not for cure of this cancer, but for prevention of a recurrence, cosmetic reasons, or because the patient doesn't want radiation. This decision doesn't have to be made immediately, and often is done after the patient has met with my colleagues in radiation oncology, medical oncology, and plastic surgery.

After the breast surgery is complete, this young woman will likely move on to chemotherapy (all premenopausal women with a tumor >1 cm are so treated). Once that is complete, radiation therapy usually begins. When all is done, it is about 8 or 9 months since first dx. I try to prepare the woman and her family for all these steps during our first few meetings, but I keep involved during this entire year to add perspective and assist decision making. Specifically, I will help counsel the patient regarding her need for genetic testing, and if positive, I will discuss the pros and cons of prophylactic mastectomy and, more importantly, the life-saving virtues of prophylactic oophorectomy.

Answer 3
In a patient identified as hypercalcemic without evidence of malignancy, my usual workup includes serum electrolytes, including calcium with simultaneous determination of intact parathyroid hormone (PTH). The dx is straightforward when the PTH is elevated in hypercalcemia. I like to confirm the dx for academic reasons using a chloride-to-phosphate ratio of >33.

If I palpate a neck nodule on physical examination, then ultrasonography may be useful to determine the presence of any thyroid nodules or occasionally to identify an enlarged parathyroid gland. If a parathyroid is palpable on physical examination, then I have to consider this a parathyroid carcinoma as the size is probably over 4 cm.

I usually obtain a sestamibi scan of the neck prior to surgery. This helps identify the side and sometimes the location of the adenoma in most cases. This information allows me to do a focused neck exploration, and keeping the dissection to the affected side minimizes potential for injury. I use an intraoperative rapid PTH assay to confirm that I have removed the adenoma. The half-life of PTH is 4 minutes, so a preoperative baseline level of 200 pg/mL should drop to 100 pg/mL within 10 minutes of removing the culprit adenoma. If it does not drop, further exploration is indicated.

Answer 4

This lesion meets the criteria for a suspicious mole. If the size is under 5 mm, I would plan an excisional biopsy with negative margins. Anything larger would necessitate a punch biopsy done in the office to make the dx and give us a depth for T stage and aid our decision on sentinel node biopsy.

Once a dx of melanoma is confirmed, if the lesion is thin (<1 mm), then the labs and CXR are adequate for staging, and a wide excision with 1-cm margins will be planned without lymph node evaluation. If this is a deep lesion (>4 mm), I will do an extensive metastatic workup, including CT of head, chest, abdomen, and pelvis, as well as a PET. Wide excision to 2-cm margins will be planned. Complete lymph node dissection would be performed in any area where nodes are palpable or positive by PET.

For intermediate-thickness lesions (1–4 mm), lymph node status is unpredictable, so a sentinel node biopsy would be planned in addition to the wide excision with 2-cm margins. On the torso I always perform a lymphoscintagram prior to surgery to identify the lymph node basin(s) that needs to be evaluated during sentinel node biopsy.

Answer 5

A good rule of thumb for breast problems is “any new finding in a postmenopausal woman is cancer until proven otherwise.” Even though this description would be consistent with a breast abscess, new cyst, or even fibroadenoma in a premenopausal woman, the top of the differential dx is cancer for this woman. Imaging is very important here, and ultrasonography is probably the most expedient way to make a dx in this instance. If a fluid-filled cavity or a mass is identified, a needle aspiration will be diagnostic. If purulent fluid is found, this woman may need an incision and drainage for a breast abscess. If a malignancy is found, then evaluation for inflammatory breast cancer would be initiated, to include MRI of the breasts, metastatic workup, and multidisciplinary consultation. In the unlikely event of a benign biopsy result, subsequent evaluation of the breast should be focused on ensuring that no malignancy is present. In the older woman with a hematoma or breast abscess, even after the mass has resolved or been drained, the patient needs a mammogram 6 months after resolution to r/o a malignancy as the root cause. Finally, there is no such thing as mastitis in a postmenopausal woman; if ultrasonography fails to identify a mass, then a skin biopsy is indicated to r/o involvement of the dermal lymphatics by breast cancer, a hallmark of inflammatory breast cancer.

Answer 6

This case is rarely seen by the surgeon first. If I had the opportunity to intervene in this man's care, I would have obtained 24-hour pH monitoring years ago when the GERD was first diagnosed. If there was significant reflux and failure of medical therapy, I would have offered him a laparoscopic Nissen fundoplication. This therapy is proven to halt the progression of Barrett's esophagus into dysplasia.

Now that this man has dysphagia, he has developed a benign stricture, or a mass lesion. Hopefully, his gastroenterologist has kept him under close surveillance with frequent upper endoscopies with biopsy to monitor development of Barrett's esophagus and subsequent dysplasia. If the biopsy indicates severe dysplasia, with greater than 50% p53 positivity, the patient needs an esophagectomy to prevent development of invasive esophageal cancer. Severe dysplasia is equivalent to in situ cancer and is curable at this stage.

If the endoscopy reveals a benign stricture with no dysplasia, then a dilation procedure is indicated. An upper endoscopy revealing a mass is a bad sign. Biopsies should be obtained to confirm esophageal cancer, and a chest/abdomen CT ordered.

Assuming no metastatic disease is encountered, I would order endoscopic ultrasonography preoperatively. This test allows you to see the depth of invasion of the primary tumor, otherwise known as the T stage. In addition, the image will show any enlarged nodes around the esophagus or along the left gastric artery (N stage). In esophageal cancer, identifying the patients with stage III disease preoperatively is beneficial as we can offer them neoadjuvant chemotherapy with or without radiation in order to downstage the tumor before surgery.

Answer 7

This presentation is most consistent with a benign nodular goiter. Often a large goiter is not symptomatic and, even when obvious to a trained observer, may not be noticed by the patient. Often the physical examination of a benign goiter just reveals thyroid enlargement without specific nodularity. The symptom reported by this patient indicates that there may be a retrosternal extension of the goiter. If CT had not been performed, I would order ultrasonography preoperatively to evaluate for suspicious nodules, and to know the size of both thyroid lobes.

Most benign goiters are best managed by total or near total thyroidectomy, especially in younger patients. A unilateral nodule, or a nodular goiter with no contralateral enlargement or nodules, may be managed by thyroid lobectomy and isthmusectomy. The pitfalls of thyroid surgery include injury to the recurrent laryngeal nerve as well as injury to the parathyroid glands. Careful dissection avoids these injuries, and morbidity is quite low in experienced hands.

Large retrosternal goiters are best approached through a standard cervical incision. Remember, the blood supply is still in the neck, so a large thyroid can be pulled out of the chest through this incision without significant risk for bleeding or injury to the anterior mediastinal structures.

Answer 8

This is a common complaint in this age group. Although most isolated adenopathy is benign self-limited reactive adenopathy, the dangerous etiologies I would entertain would be infectious and malignant. At the top in the college crowd is mononucleosis, a common viral entity in dormitory situations. A quick Monospot test will be helpful in ruling this in, but a negative test does not r/o a viral etiology. In this age group, lymphoma is the top etiology for a malignant node.

Fatigue does not differentiate between these entities, but absence of other B symptoms is helpful. I usually work these patients up with a CBC and a CXR, in addition to a careful head and neck examination, including the oral cavity. I bring these patients back for a 3-month follow-up examination to make sure there is no change in the adenopathy or interval development of important symptoms or signs.

Lastly, for progressive adenopathy, or adenopathy associated with symptoms of malignancy, an excisional biopsy of the node is the best way to diagnose lymphoma. The node should be kept intact to assist with morphologic characterization of the lymphoma, and to provide tissue for a flow cytometry analysis.

Answer 9

This case is typical for a deep extremity soft tissue sarcoma. Because there is no superficial mass to palpate, the presentation is commonly insidious. Many sarcomas do not present until they are very large because they develop in areas that are not easy to assess; retroperitoneal, gluteal, and thigh are the areas with the largest tumors at dx. Swelling in the calf (when unilateral especially) should be evaluated from a vascular or lymphovascular point of view first.

When evaluation shows normal blood flow and no deep vein thrombosis in the extremity or obstructing mass in the pelvis, the workup should move to imaging the extremity to look for a mass.

In this case the MRI of the extremity may reveal a sizable tumor in the deep or superficial compartments of the calf, without significant vascular compromise. A core needle biopsy may be attempted using CT or ultrasound guidance to help identify the type of sarcoma. A benign intramuscular lipoma would look identical but may not require the same extent of resection as a liposarcoma here.

Staging workup includes a CXR at least, and usually chest CT to r/o pulmonary metastases prior to resection.

Surgical planning includes informing the patient that a wide excision to negative margins will be performed, that neurovascular structures will be preserved as much as possible, and that amputation is almost never indicated in a primary resection. The tumor should be removed en bloc without traversing the capsule (pseudocapsule), oriented so pathology may assess margin status, and the cavity marked with metal clips for subsequent radiation therapy if indicated.

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Chapter 32
Vascular Tools

Lino F. Miele MD, MS *and Alexander Uribe* MD

Section Editor's Note

There is more to understanding a diagnostic study than simply reading the interpretation. The physician who understands the **theory** behind a test, how a test is performed **technically** and how it is **interpreted** and **applied,** will be best able to use the results of that test in the evaluation and treatment of the patient.

Accordingly, in the discussion of the first two Vascular Tools (Ankle-Brachial Index and Lower Extremity Arterial Duplex), a model is offered for consideration that can be used to organize background information on the tests that you commonly order. Given the constraints of space in this book, only two Tools will be covered in this manner; for the remaining Tools we give you "indications" only. You can find the more complete information on the Web site of this book.

Ankle-Brachial Index

Indication

Indications include a clinical history consistent with peripheral vascular disease, including claudication, rest pain or tissue loss, or a physical examination indicating decreased or absent pulses.

Theory

The ankle-brachial index (ABI) is a noninvasive measurement of the hemodynamic consequences of aortoiliac, femoropopliteal, and tibial occlusive disease.

Technical

The ankle systolic pressure is compared (indexed) with the brachial systolic pressure. A pneumatic cuff (blood pressure cuff) is wrapped around the ankle. Using a Doppler, flow is identified in the dorsalis pedis and posterior tibial arteries. With inflation of the cuff, blood flow is occluded. The ankle systolic pressure (P_{Ankle}) in the dorsalis pedis and posterior tibial arteries is the pressure at which flow returns when the cuff is deflated. In a similar fashion, the right and left brachial artery systolic pressures are obtained. The ankle pressures are compared to the higher of the two brachial pressures ($P_{Brachial}$):

$$ABI = P_{Ankle}/P_{Brachial}$$

Interpretation

The study provides an ABI for the dorsalis pedis and posterial tibial artery. Generally the higher of the two is considered to provide an estimate of flow to the ankle. Normally the ankle systolic blood pressure is equal to or higher than the brachial systolic pressure. The normal ABI is 1 to 1.2, and less than 0.9 is abnormal. Patients with claudication have ABIs from 0.5 to 0.8, whereas patients with rest pain have ABIs less than 0.3.

Application

The ABI should always be interpreted in the perspective of the patient's clinical symptoms. Frequently a patient's clinical symptoms can improve even though there may be no change in the ABI.

Additional Considerations

Diabetic patients can have circumferential calcification involving the media of midsized arteries, such as the superficial femoral, popliteal, and tibial arteries. The circumferential calcification prevents compression of the arteries, resulting in artifactual elevation of the ankle pressure and the ABI. **See Sabiston 66, Becker 37.**

Lower Extremity Arterial Duplex

Indication

Low cost and lack of morbidity make detailed lower extremity duplex ultrasound arterial mapping a useful tool. Duplex imaging has generally supplanted segmental pressure measurement as a tool to localize the level or levels of obstruction and to characterize the length of obstruction and the degree of stenosis.

Theory

Ultrasonography may be used not only to determine the direction and velocity of blood flow (***Doppler ultrasound***), but also to sense the depth and amplitude of signals reflected from a stationary interface. This creates an image of the subjacent structures (***B-mode ultrasound***). If the B-mode images can be displayed at a sufficient rate (>15 frames per second), then a real-time video image can be obtained (***real-time B-mode ultrasound***).

Technical

The common femoral, superficial femoral, popliteal, and tibial arteries are visualized using real-time B-mode imaging. Areas of atherosclerotic plaque can be assessed for evidence of increased flow velocity using Doppler ultrasound.

Velocity is indirectly related to cross-sectional area. If flow is constant, velocity must increase as the cross-sectional area decreases. The increased velocity associated with a stenosis can be measured using Doppler ultrasound.

Interpretation

The presence of intimal thickening, atherosclerotic plaque, or arterial obstruction is noted. Stenosis is indicated by an increase in flow velocity. A severe stenosis is indicated by a two- to threefold increase in velocity.

Application

The study may also be used for the selection of normal or less calcified arterial segments for anastomosis in bypass procedures. **See Sabiston 66, Becker 37.**

Segmental Pressure Measurement

Indication

The ABI quantifies the reduction in arterial flow secondary to atherosclerotic involvement of the aorta and the arteries of the lower extremity. Segmental pressure measurement is used to localize the level of atherosclerotic obstruction(s). **See Sabiston 66, Becker 37.**

Transcutaneous Tissue Oxygen Tension (T_cPO_2)

Diabetic patients frequently have circumferential calcification of the arterial media. This interferes with compression of the tibial arteries and prevents accurate measurement of the ankle systolic pressure. As a result, the ankle brachial index is artifactually elevated, often with values greater than 1.4. In order to more accurately assess perfusion of the distal extremity and the potential for wound healing, the tissue oxygen tension ($TcPO_2$) can be assessed percutaneously using a probe on the skin surface. Values greater than 30 to 40 mmHg suggest a circulation adequate to achieve wound healing. Toe pressure measurements have also been used for the same purpose.

Carotid Duplex Imaging

Indication

A carotid duplex examination is indicated for patients with either symptomatic or asymptomatic cerebrovascular disease. Asymptomatic patients may have a carotid bruit or a history of, or risk factors for, atherosclerotic vascular disease. See Figure 32-1 for an image from a cerebrovascular duplex examination showing the carotid bifurcation. The common (C), external (E), and internal (I) carotid arteries are indicated. **See Sabiston 66, Becker 37.**

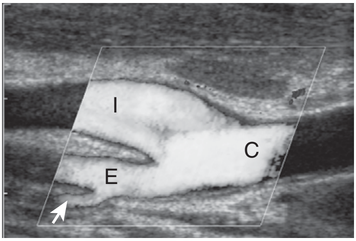

Figure 32-1 The arrow indicates the superior thyroid artery, the first branch of the external carotid artery.

Lower Extremity Venous Duplex Imaging

Indication

Patients presenting with the clinical manifestations of venous disease, including acute deep venous obstruction/thrombosis (DVT) or chronic venous insufficiency secondary to valvular incompetence should be evaluated using venous duplex imaging. The absence of venous flow and incompressibility of the vein are associated with venous thrombosis. Reversal of flow during the Valsalva maneuver indicates valvular incompetence and venous reflux. **See Sabiston 66, Becker 37.**

Arteriography

Indication

Arteriography is the study of arteries following the injection of contrast media. It was the definitive diagnostic tool used to identify the cause of a patient's symptoms, determine possible treatment options, and provide anatomical information necessary to plan treatment. It was used in patients with symptomatic and asymptomatic carotid occlusive disease, as well as patients with symptomatic peripheral vascular disease. Due to its invasive nature, arteriography has generally been supplanted by duplex ultrasonography, magnetic resonance arteriography (MRA), and computed tomographic arteriography (CTA).

Current indications include equivocal or nondiagnostic duplex ultrasonography, MRA, or CTA; angiography is also used in combination with endovascular intervention. **See Sabiston 66, Becker 37.**

MRA/CTA

Indication

MRA and CTA have generally replaced contrast arteriography as a diagnostic imaging study. The CT angiogram in Figure 32-2 demonstrates a computerized reconstruction of an aortic aneurysm in a 78-year-old woman. **See Sabiston 66, Becker 37.**

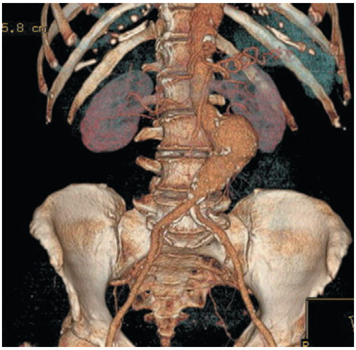

Figure 32-2

Venography

Indication

Venous duplex imaging is now the initial diagnostic study used to determine the presence or absence of DVT. Magnetic resonance venography or CT venography can also be used in equivocal situations. Venography is used infrequently to evaluate a patient for DVT, but remains an important study for evaluation of nonthrombotic venous pathology. **See Sabiston 68.**

Chapter 33
Teaching Visual: Peripheral Vascular Reconstruction

Thomas G. Lynch MD

Objectives

- Draw the important vascular anatomy of the lower extremity.
- Diagram a vascular bypass for your patient.

Medical Knowledge

Anatomy

The aorta divides into the common iliac arteries, and these divide into the external and internal iliac arteries. The external iliac artery continues under the inguinal ligament as the common femoral artery, which divides into the superficial femoral and deep femoral (profunda femoris) arteries. The profunda femoris artery usually arises 3 to 4 cm below the inguinal ligament from the lateral border of the artery and gives rise to several branches, which anastomose with branches of the internal iliac artery to provide collateral circulation in the presence of external iliac artery occlusion.

The superficial femoral artery (SFA) extends downward through the thigh, where it becomes the popliteal artery after it exits the lower boundary of the adductor canal through the adductor hiatus.

Below the knee, the popliteal artery becomes the tibioperoneal trunk after the takeoff of the anterior tibial artery. The tibioperoneal trunk bifurcates to form the posterior tibial and the peroneal arteries.

Interpersonal and Communication Skills

"A Picture Is Worth a Thousand Words"

This is certainly true in vascular surgery, where visualization of the arterial anatomy is essential in planning an operation or intervention. Figure 33-1 illustrates three different tools that can be helpful when interacting with patients. Patients often appreciate seeing the actual results of studies that were performed during their diagnostic workup. (1) Arteriographic images show the aortic and common femoral bifurcations, and the origin of the tibial arteries at the popliteal trifurcation. (2) An artist's rendering, shown on the patient's left leg in the drawing, can also be used to simplify the anatomy during the course of patient education. (3) In the absence of formal images, the physician can draw the anatomy. *Connect the dots to practice drawing the anatomy of the lower extremity arterial circulation.*

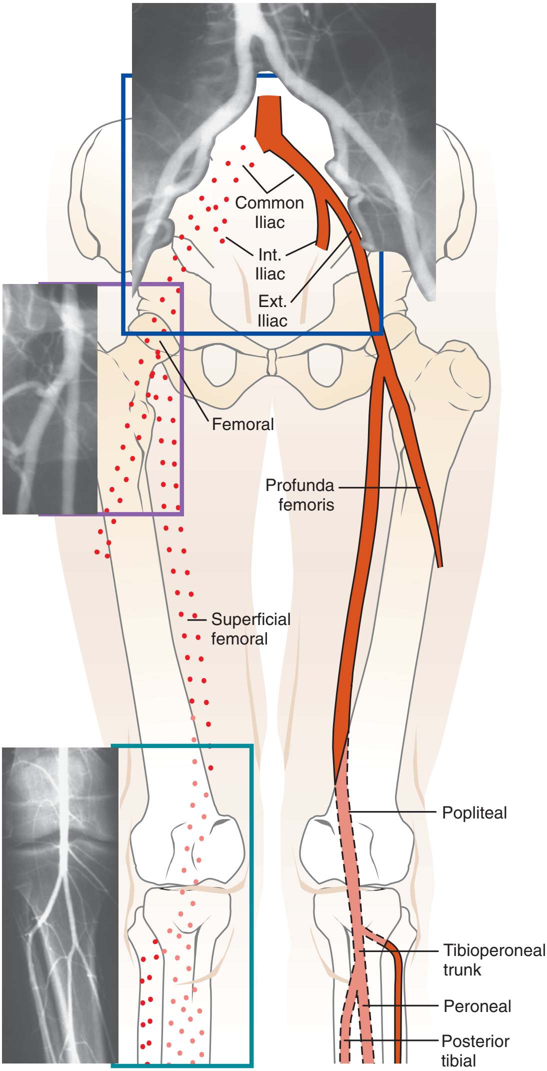
Common
Iliac
Int.
Iliac
Ext.
Iliac
Femoral
Profunda
femoris
Superficial
femoral
Popliteal
Tibioperoneal
trunk
Peroneal
Posterior
tibial

Figure 33-1

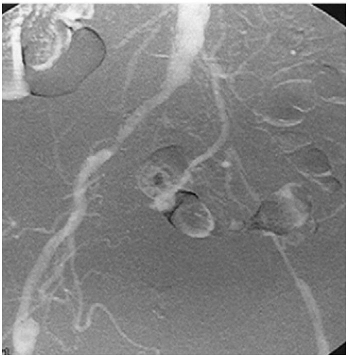

Figure 33-2 Iliac occlusion

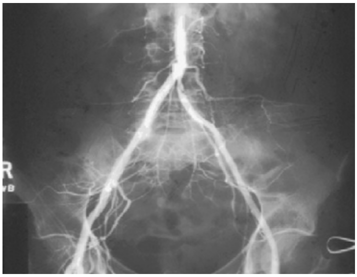

Figure 33-3 Iliac stenosis

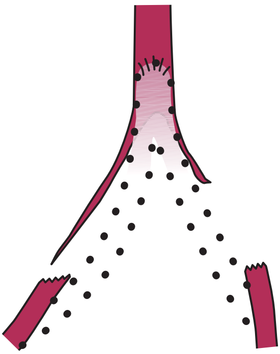

Figure 33-4

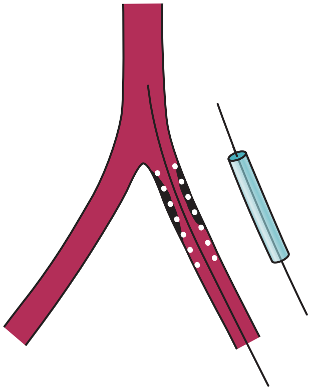

Figure 33-5

Interpersonal and Communication Skills

Figures 33-2 and 33-3 illustrate two variations of aortoiliac disease: diffuse bilateral iliac artery disease with a left iliac artery occlusion (Fig. 33-2) and a focal left iliac artery stenosis (Fig. 33-3) just beyond the aortic bifurcation. Use the figures to illustrate an aortofemoral bypass (Fig. 33-4) and a left iliac artery angioplasty (Fig. 33-5).

Chapter 34
Peripheral Arterial Disease (Case 20)

Thomas G. Lynch MD

Patient 1 63-year-old man with exercise-induced right calf pain relieved by rest

Patient 2 56-year-old man with impotence and bilateral thigh pain with walking

Patient 3 45-year-old diabetic woman with nonhealing plantar foot ulcer

Patient 4 72-year-old woman with atrial fibrillation and acute left leg pain

Patient 5 65-year-old man with nocturnal foot pain relieved by sitting on side of bed

Editor's note: In each chapter in this section the Differential Diagnosis box has been replaced by a Framework for Clinical Thinking box to help direct the sorting process. Problems associated with vascular disease are most often different manifestations of the same few underlying etiologies (i.e., atherosclerotic obstructive disease, embolus, aneurysmal degeneration). The differential dx, therefore, is not only a differential of pathology but also a differential of **timing, process,** and **location.** Accordingly, patients have been selected to demonstrate the common presenting complaints.

Framework for Clinical Thinking

Patient	Symptom	Timing	Process	Location
1	Calf pain claudication	Chronic	Atherosclerotic obstructive disease	Superficial femoral/ popliteal artery
2	Thigh pain claudication	Chronic	Atherosclerotic obstructive disease Spinal stenosis	Aorta; iliac artery Lumbosacral spine
3	Tissue loss	Chronic	Atherosclerotic obstructive disease Diabetic neuropathy	Femoropopliteal, tibial artery

4	Leg pain	Acute	Arterial embolus	Cardiac Atheroembolic arterial disease Arterial aneurysm
5	Rest pain	Chronic	Atherosclerotic obstructive disease	Multilevel arterial

Note that **Symptom** and **Timing** are reported by the patient. **Process** is an assumption, and **Location** is deduced from that assumption. Process and location need to be verified by physical examination and other appropriate studies.

Speaking Intelligently

Patients with peripheral vascular disease may remain asymptomatic or may present with a spectrum of symptoms. In order of severity, symptoms begin with claudication, progress to rest pain, and culminate with tissue loss.

I use the following framework as a basis for organizing my approach to the patient presenting with leg pain. I first characterize the onset of the patient's symptoms. Was the onset acute, or did the symptoms develop over time? Next I attempt to use the hx and physical examination to localize the level or levels of arterial obstruction. The levels can be broadly classified as aortoiliac, femoropopliteal, or tibial. Finally, I use the physical examination to determine the viability of the extremity (following an acute presentation) and to look for evidence of limb-threatening conditions, such as open wounds, chronic ulcers, or gangrenous changes.

PATIENT CARE

Clinical Thinking

- In assessing the patient with leg pain it is important to make the distinction between a lifestyle-limiting process, such as claudication, and a limb-threatening process, such as rest pain or tissue loss.
- Initially modification of risk factors and pharmacotherapy (cilostazol) should be implemented in those patients with claudication. Limb-threatening ischemia, which can be associated with the acute onset of symptoms or evidence of tissue loss, will generally require some form of operative or interventional procedure.

History

- Ask questions that will further characterize the presenting complaint. For those patients with claudication and rest pain, define the acuity of the onset and the character of the pain. What is the location of

the pain? How have the symptoms changed since the onset? What factors make the pain better or worse? Is there associated tissue loss?
- The onset of symptoms can be acute or gradual. Acute onset may be associated with arterial thrombosis or embolus. A gradual onset may suggest the progressive development of an atherosclerotic obstructive process.
- The character of the pain associated with peripheral vascular disease can vary. Claudication is frequently described as an aching or cramping discomfort associated with exercise, but it can also be described as a heaviness, tiredness, or weakness.
- The symptoms of claudication occur with walking and are relieved with rest. The symptoms of rest pain are associated with elevation of the extremity and relieved with dependency. For patients with claudication, the extent of the disability can be measured in terms of exercise tolerance. How many city blocks, or how many flights of stairs, can the patient walk before the onset of symptoms?
- Patients with peripheral vascular disease may also have an associated hx of smoking, diabetes, hypertension, or hypercholesterolemia. Ask about a prior hx of stroke or myocardial infarction.

Physical Examination

- Observe for evidence of skin changes or tissue loss. Describe the location, size, and depth of any wounds. Evidence of infection (purulence and extent of cellulitis) or the presence of exposed bone should be noted.
- Dependent rubor, associated with advanced ischemia, is a reddish blue discoloration that develops when the patient sits or stands, with the extremity in a dependent position. It is generally confined to the foot. When the extremity is elevated, the foot becomes pale white in appearance (pallor on elevation).
- Palpate the carotid, brachial, femoral, popliteal, dorsalis pedis, and posterior tibial pulses. While there are many ways to assess or classify a pulse, the simplest characterizes the pulse as absent (0), decreased (1+), or normal (2+). The aorta, as well as the femoral and popliteal pulses, should also be assessed for evidence of aneurysmal dilatation.
- In examining patients presenting with the acute onset of symptoms, it is important to assess the viability of the extremity. Is there preservation of motor and sensory function? What is the extent of any tissue loss?

Tests for Consideration

- **Ankle-brachial indices:** The ankle-brachial index provides a measure of the extent of aortoiliac, femoropopliteal, and tibial occlusive disease. An index of 1.0 or greater is normal. A decrease suggests disease. An index of 0.5 to 0.8 is typical in the patient with claudication. An index of less than 0.3 can be seen with rest pain and tissue loss. **$85**

IMAGING CONSIDERATIONS

→**Duplex imaging:** The study can identify the level or levels of atherosclerotic involvement and can also characterize the extent (length and degree of stenosis) of disease identified. **$250**

→**CT angiography (CTA) and magnetic resonance angiography (MRA):** Advanced, and more expensive, imaging studies. These are noninvasive techniques providing cross-sectional and high-resolution, three-dimensional reconstructions of the aorta and arteries of the lower extremity. The studies can be overly sensitive with decreased specificity. **$1,500**

→**Contrast angiography:** Advanced and invasive imaging study. It has the risks of arterial injury and contrast allergy and/or nephropathy. Its use has decreased as the quality and accuracy of MRI and CTA have increased. **$2,000**

Clinical Entities — Medical Knowledge

Aortoiliac Disease

Pφ Obstruction associated with aortoiliac disease can involve the distal aorta and/or one or both of the iliac arteries. Leriche syndrome describes the association of aortoiliac occlusive disease, claudication, and impotence.

TP The typical patient presents with buttock and/or thigh pain, which occurs with walking. The symptoms are relieved promptly if the patient stops and rests and recur when the patient resumes walking. On physical examination, one or both femoral pulses will be absent or decreased (***Patient 2***).

Dx The association of buttock or thigh claudication and the absence of femoral pulses should indicate the presence of an aortoiliac obstructive process.

Tx Therapy is dependent on the patient's lifestyle and the extent of the disability. Patients without significant limitation can be treated medically with risk factor modification and pharmacotherapy (cilostazol). Risk factor modification includes smoking cessation, the control of hypertension, hypercholesterolemia, and diabetes, and continued exercise. If the symptoms significantly alter the patient's lifestyle (this is a subjective determination on the part of the patient), MRA or CTA can be used to localize and characterize the obstructive process. Therapeutic options include angioplasty and stenting, or aortofemoral, axillofemoral, or femorofemoral reconstruction. **See Sabiston 66, Becker 37.**

Femoropopliteal Disease

Pφ Obstruction of the femoral or popliteal arteries results in a reduction in blood flow to the calf muscles. The disease process often begins in the region of the adductor hiatus. Involvement may be unilateral or bilateral.

TP The patient may present with unilateral or bilateral calf discomfort with walking. Symptoms are relieved if the patient stops and rests. On physical examination the femoral pulses are present. The popliteal, dorsalis pedis, and posterior tibial pulses are absent (***Patient 1***).

Dx The clinical hx and physical findings should provide evidence of femoropopliteal obstruction. The ankle-brachial index is generally between 0.5 and 0.8.

Tx Since the results of surgery or intervention involving the smaller femoral and popliteal arteries are not as good as the results of aortic or iliac reconstruction/intervention, it is recommended that patients with femoropopliteal obstruction and claudication be treated initially with risk factor modification and pharmacotherapy. **See Sabiston 66, Becker 37.**

Popliteal-Tibial Occlusive Disease

Pφ Diabetes can be associated with a small vessel occlusive process. From a vascular perspective, involvement of the distal popliteal and tibial arteries is frequently seen in the diabetic patient. Pathologically, the vessels demonstrate a circumferential calcification of the arterial media.

TP The typical patient may present with claudication or tissue loss. In the diabetic patient, tissue loss can be associated with neuropathy, osteomyelitis, and/or ischemia. On physical examination, the femoral and popliteal pulses may be present. The dorsalis pedis and posterior tibial pulses are absent (***Patient 3***).

Dx Diabetic patients will frequently have artifactual elevation of ankle-brachial indices. Diabetic medial calcification is a circumferential process that prevents occlusion of the tibial arteries by the blood pressure cuff. An ankle-brachial index of greater than 1.3 suggests artifactual elevation. Because the ankle-brachial index may not accurately reflect the extent of disease, toe pressures or transcutaneous oxygen (TcP_{O_2}) measurements may be necessary to accurately assess the extent of the distal circulation.

Tx In the absence of limb-threatening ischemia (rest pain or tissue loss), patients with claudication are treated medically, with risk factor modification, exercise, and pharmacotherapy (cilostazol).

For those patients with tissue loss, if the etiology is neuropathic and there is no evidence of osteomyelitis or decreased circulation, custom foot wear to relieve uneven pressure distribution is appropriate. Osteomyelitis will generally require resection or debridement. In the presence of adequate circulation, digital or forefoot amputation may be appropriate. In the presence of decreased circulation, neuropathic ulceration and osteomyelitis will require endovascular intervention or reconstruction. These patients may need further imaging using MRA or CTA. It is important to assess renal function in these patients before proceeding with the use of a contrast agent. Therapeutic options include intervention (angioplasty, atherectomy, or stenting) or surgical reconstructive procedures (femoral-popliteal or femoral-tibial bypass). **See Sabiston 66, Becker 37.**

Nondiabetic Tissue Loss

Pφ In nondiabetic patients, tissue loss may be seen in patients with multilevel arterial disease (aortoiliac and femoropopliteal obstruction). Tissue loss is infrequently associated with single-level disease, except in the diabetic patient with popliteal-tibial disease.

TP The typical patient will present with a nonhealing ulceration(s) involving one or more digits, the plantar foot, and/or the medial or lateral foot. In the nondiabetic patient, the femoral, popliteal, dorsalis pedis, and posterior tibial pulses will be absent.

Dx On physical examination any evidence of tissue loss should be documented and characterized. Pulse status should be assessed. Ankle-brachial indices and duplex imaging can be used for initial diagnostic screening. Radiographs of the foot may be obtained to look for evidence of osteomyelitis. Toe pressures or $TcPO_2$ measurements may be of value in assessing the adequacy of the distal circulation and the potential for wound healing.

Tx Therapeutic options include interventional angioplasty and stenting or surgical reconstruction. **See Sabiston 66, Becker 37.**

Rest Pain

Pφ Rest pain is the result of a significant decrease in circulation. As such, it involves the most distal aspect of the extremity. The forefoot and digits are most commonly involved; rest pain does not involve the thigh or calf. The symptoms classically are relieved with dependency, as gravity tends to facilitate blood flow. The symptoms are aggravated if the patient lies down or elevates the extremity, as this further decreases flow to the foot (***Patient 5***).

TP The typical patient complains that foot pain awakens him at night or develops soon after lying down; if the patient sits up or hangs the leg over the edge of the bed, it is possible to obtain some relief. Relief of symptoms with dependency is an important factor in distinguishing rest pain from neuropathy. Neuropathy can present as numbness or pain and discomfort. It is seen frequently in the diabetic patient and often involves the foot and digits. Unlike rest pain, the symptoms of neuropathic pain do not resolve with dependency. They remain unchanged.

Dx On examination, the extremity frequently demonstrates evidence of dependent rubor with pallor on elevation. At a minimum, the popliteal, dorsal pedis, and posterior tibial pulses are absent; frequently femoral pulses are also absent. The ankle-brachial index will be reduced, with values in the range of 0.3 or lower. MRA, CTA, or contrast angiography will be necessary to determine options for intervention or reconstruction.

Tx Patients with ischemic rest pain are at significant risk to lose an extremity. Therapy may involve angioplasty or stenting, but most commonly will require surgical reconstruction. Options include femoropopliteal or femoral tibial bypass procedures. The conduit used for the bypass should be autogenous, such as saphenous vein. **See Sabiston 66, Becker 37.**

Spinal Stenosis

Pφ Spinal stenosis can frequently be confused with claudication of vascular etiology. The symptoms result from distal cord compression or compression of the cauda equina. This can result in the development of lower extremity discomfort with positional changes, with walking, or with activity. Because the symptoms are not related to metabolic demand and arterial flow, the onset is inconsistent. Similarly, the patient does not obtain relief if he simply stops and rests. It is often necessary to sit down or lean forward in order to obtain relief. The act of leaning forward opens the spinal canal and relieves compression. Resolution of the pain associated with spinal stenosis may take 30 to 60 minutes.

TP The typical patient may complain of buttock, thigh, or calf discomfort that occurs with walking. The patient will generally find it difficult to determine with consistency how far he must walk prior to the onset of symptoms. The patient will have to sit down for 30 to 60 minutes in order to obtain relief.

Dx The patient should be evaluated for the presence of arterial disease by hx and physical examination. Ankle-brachial indices can be used to objectively quantify any arterial obstructive component. In patients with spinal stenosis, MRI of the lumbosacral spine will demonstrate narrowing of the canal or compression of the cord.

Tx Patients with spinal stenosis may benefit from a laminectomy or decompression. **See Sabiston 72, Becker 48.**

Arterial Embolus

Pφ Arterial emboli may lodge in the larger iliac, femoral, or popliteal arteries or the most distal plantar or digital arteries. Atrial fibrillation can be associated with the development of atrial thrombus; ventricular thrombus may develop following an acute myocardial infarction. Emboli from the heart commonly occlude the larger arteries and are associated with the acute onset of ischemia involving the thigh, calf, and/or foot. The six P's have been used to describe the complex of symptoms: ***pain, pallor, paresthesia, paralysis, pulselessness,*** and ***poikilothermia.***

Microembolization of cholesterol or platelet debris can arise from areas of arterial wall irregularity or ulceration. This can result in the "blue toe syndrome," or the acute onset of painful, bluish discoloration of the toe(s). Involvement of the toe(s) of one extremity may suggest a source in the ipsilateral iliac or femoral arteries. Bilaterality suggests the presence of an aortic source of emboli.

Arterial emboli or microemboli may also be associated with aneurysmal dilatation involving the aorta or peripheral arteries (see discussion in Chapter 35, Arterial Aneurysms).

TP The patient with an acute proximal arterial embolus will classically present with the acute onset of calf or foot pain with an associated decrease in motor or sensory function (***Patient 4***). The foot is pale and cool to touch. The patient may have a prior hx of emboli, but frequently has no prior hx of claudication. On physical examination, the heart rate may be irregularly irregular (atrial fibrillation). Pulses in the involved extremity may be decreased or absent. Emboli at the aortic bifurcation or in the iliac artery will be associated with an absent femoral pulse(s). Emboli involving the common femoral bifurcation, the superficial femoral artery, or the popliteal artery can be associated with a "water-hammer" femoral pulse and absent popliteal, dorsalis pedis, and posterior tibial artery pulses.

Microemboli can result in the acute onset of pain in one or more digits with associated bluish discoloration even in the presence of palpable pulses.

Dx With a proximal arterial embolus, hx and physical examination should be sufficient to establish a dx. Patients presenting with evidence of distal microembolization should have a transesophageal echocardiogram to assess the atria and ventricles for evidence of thrombus, and the arch and descending aorta for evidence of arterial wall irregularity and ulceration. A CTA can be used to assess the abdominal aorta and iliac arteries for evidence of aneurysm, wall irregularity, and ulceration. Lower extremity arterial duplex imaging may be used to assess the femoral and popliteal arteries for evidence of stenosis, ulceration, or aneurysm.

Tx Following dx, the patient should be anticoagulated. Operative embolectomy is one therapeutic option for proximal, large vessel emboli. If the extremity is viable, and the embolus involves the distal superficial femoral and popliteal arteries, endovascular lytic therapy may be an option. *Anticoagulation with Coumadin is continued for 4 to 6 months.*

Antiplatelet agents are generally used to treat patients with "blue toe syndrome" in the absence of an intracardiac source of embolus. **See Sabiston 66, Becker 37.**

Arterial Thrombosis

Pφ Low flow and stasis secondary to preexisting atherosclerotic disease can result in thrombosis of the iliac, femoral, or popliteal arteries. Because of the preexisting atherosclerotic process, patients will frequently have a prior hx of claudication. A hx of previous reconstructive procedures also puts the patient at risk for thrombosis.

The spectrum of symptoms associated with arterial thrombosis may parallel that seen following embolic occlusion, although the severity may be less because of the preexisting atherosclerotic process and the prior development of collateral circulation.

TP The clinical presentation associated with acute arterial thrombosis is similar to that seen following acute embolic occlusion: the onset of calf or foot pain with an associated decrease in motor or sensory function. The foot is pale and cool to touch. The patient may have a hx of claudication or prior bypass. On physical examination, pulses in the involved extremity may be decreased or absent.

Dx Hx and physical examination should be sufficient to establish a dx. The ankle pressure is frequently unobtainable. Duplex imaging may be used to further characterize the level of obstruction. If the extremity is viable, advanced imaging, using MRA, CTA, or contrast angiography, is essential to determine the reconstructive options

Tx For the patient with a viable extremity, therapeutic options include lytic therapy, combined with angioplasty or stenting, or operative intervention. Patients with a nonviable extremity will generally require urgent operative intervention, graft thrombectomy and revision, or graft replacement. **See Sabiston 66, Becker 37.**

ZEBRA ZONE

a. **Popliteal artery aneurysm:** Unlike aortic aneurysms, which typically rupture as they increase in size, femoral and popliteal aneurysms will thrombose or embolize. This can result in the acute onset of lower extremity ischemia (popliteal aneurysms are covered in greater detail in Chapter 35, Arterial Aneurysms). **See Sabiston 65, Becker 37.**

b. **Popliteal artery entrapment:** The popliteal artery may pursue one of several anomalous courses through the popliteal fossa. Most frequently seen in younger individuals, this may result in compression of the artery by investing tendons or muscle, with the subsequent development of claudication-like symptoms. It is frequently associated with the presence of a normal physical examination at rest. Distal pulses may decrease with plantar or dorsiflexion of the foot, accentuating compression of the artery. CT or MRI can be used to demonstrate the anomalous course of the artery in the popliteal fossa. **See Sabiston 67.**

c. **Classic symptoms of claudication in the presence of a normal physical examination:** The patient gives a classic hx of claudication, but is found to have a normal physical examination. It is critical to recall that the patient's symptoms develop with exercise, yet the examination takes place at rest. Reexamining the patient after exercise may demonstrate a decrease in femoral and popliteal pulses, as well as a decrease in ankle-brachial indices. **See Sabiston 66, Becker 37.**

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
Intermittent claudication: its natural course

Authors
Imparata AM, Kim GE, Davidson T, Crowley JG

Reference
Surgery 1975;78:795–799

Problem
How aggressively should patients with claudication be treated?

Intervention
Patients who were seen for the primary complaint of claudication did not undergo immediate arterial reconstruction but were followed clinically for an average of 2.5 years.

Quality of evidence
Prospective analysis of 600 patients

Outcome/effect
The study suggests that intermittent claudication is relatively indolent, with only 5.8% of patients coming to amputation during a 2.5-year mean follow-up. Prognosis is determined by the severity of below-knee arterial involvement and apparent inability to compensate for ischemia via collateral circulation.

Historical significance/comments
The study shows the value of knowing the natural hx of a disease process. The data provided the basis for initial conservative management of patients with claudication. At the time of the study, the relationship between risk factors and atherosclerotic vascular disease was not well established, and risk factor modification was not aggressively pursued, as it is now.

Interpersonal and Communication Skills

Involving the Patient in Decisions
It is critical to involve the patient in any decision regarding therapy, particularly for symptoms of claudication. Operations and interventions for claudication are generally performed only to relieve symptoms and not to decrease the long-term risk for limb loss. In speaking with the patient it is important to determine the disability and the extent of any limitation in activities. Emphasize that any decision regarding therapy is dependent on the extent of the patient's personal disability. If the symptoms do not significantly limit activities, intervention is probably not required and the patient may be treated with risk factor modification, pharmacotherapy, and exercise. If the symptoms do result in a significant alteration in lifestyle, then intervention can be considered. It is important to emphasize that intervention should be associated with complications and rarely with limb loss. Complications can include a catheter-based injury to the artery, contrast-induced nephropathy, or operative morbidity and mortality. Invite questions and do not press for an immediate answer as the patient will need time to absorb and reflect on the information. When the patient's medical decision depends on several variables, provide information in writing. Most patients cannot take in all the information in one conversation, and they will benefit from material they can reference later.

Professionalism

Commitments to Honesty with Patients and to Professional Competence

The field of vascular surgery is developing rapidly. Percutaneous angioplasty and endovascular stents have now become important techniques in the vascular surgeon's armamentarium. Rapid technological developments challenge the **professionalism** of the vascular surgeon. As a ***professional***, one must continue to update skills to stay current with advances in the field. This presents the challenge of continuing to learn new techniques in mid-career and developing processes by which one can be monitored and credentialed to perform these new procedures independently and safely.

A situation may arise where you recognize that a patient referred to you could benefit from a new technique, but you yourself have not yet achieved competence in the new technique. A dilemma occurs: Do you rely on the intervention with which you are familiar, or do you refer the patient elsewhere? These decisions should always be made from a patient-centered perspective.

Systems-Based Practice

Hospital Economics: Fixed Costs, Beds, and Length of Stay

Mr. J. is a 72-year-old man who presents with severe chest pain. You bypassed his superficial femoral artery occlusion 2 years ago. The surgery went well, but his postoperative course had been complicated by aspiration pneumonia and a 1-month stay in the ICU. His graft is now occluded and an angiogram demonstrates that his run-off is poor. Recognizing that Mr. Jones has returned, a hospital administrator is concerned that "the hospital can't afford another prolonged post-op course!"

Hospital costs have significant economic impact, and these costs are incurred regardless of whether the hospital is filled with patients. In order for a hospital to break even, a portion of the fixed costs of running the entire hospital—the capital cost of the building, the nursing staff payroll, the cost of administration—is allocated to every patient. Patients with low health coverage typically do not cover these *fixed costs,* and therefore the hospital may rightly claim that they are losing money on these patients. Hospitals do, however, typically cover their *variable costs*. When payments are "fixed" for a specific dx, an excessive length of stay impacts hospital costs and profits.

Chapter 35
Arterial Aneurysms (Case 21)

G. Matthew Longo MD

Patient 1 65-year-old man with abnormal CXR showing a dilated thoracic aorta

Patient 2 70-year-old woman with a palpable pulsatile abdominal mass

Patient 3 62-year-old man with the onset of painful blue toes, left foot

Patient 4 **(call from the Emergency Department)** 67-year-old man with hypotension and the acute onset of abdominal and back pain

In each chapter in this section the Differential Diagnosis box has been replaced by a Framework for Clinical Thinking box to help direct the sorting process. See the editor's note on page 249.

Framework for Clinical Thinking

Patient	Symptom	Timing	Process	Location
1	Asymptomatic (CXR finding)	Chronic	Aneurysmal degeneration	Thoracic aorta
2	Asymptomatic (incidental finding on physical exam or diagnostic study)	Chronic	Aneurysmal degeneration	Abdominal aorta
3	Ischemic toes	Acute	Aneurysmal degeneration Embolus, thrombosis	Distal arteries
4*	Hypotension Abdominal and back pain	Acute	Aneurysmal degeneration; rupture	Abdominal aorta

*Note: Patient 4, with a ruptured abdominal aortic aneurysm, is considered in Chapter 19, Abdominal Pain and Hypotension (Case 9).

Note that **Symptom** and **Timing** are reported by the patient. **Process** is an assumption, and **Location** is deduced from that assumption. Process and location need to be verified by physical examination and other appropriate studies.

Speaking Intelligently

When I am asked to see a patient with an aneurysm, it is usually in one of two contexts: an emergent presentation in a symptomatic patient or an elective evaluation of an asymptomatic patient.

In the acute setting of rupture, or a high suspicion of rupture, time should not be wasted obtaining unnecessary diagnostic studies. Abdominal ultrasonography in the emergency department can identify the presence of an aneurysm or a retroperitoneal hematoma. If the patient is ***hemodynamically stable*** upon presentation, a CT scan can help determine if an open or endovascular repair is the best tx option. Following initial assessment and dx, resuscitation and intervention should take place in the operating suite.

A vascular surgeon is frequently asked to see an asymptomatic patient with a suspected aneurysm of the thoracic or abdominal aorta. Peripheral arterial aneurysms, although less frequent, can involve the subclavian, femoral, or popliteal arteries. Electively, I use the hx and physical examination to help determine the presence and extent of symptoms, if any; the approximate size and location of the aneurysm; and the associated presence of peripheral vascular disease or other aneurysms. The least expensive screening study is an ultrasound examination, which can provide an estimate of the size or diameter of the artery. If an aneurysm is confirmed, ***CT angiography*** can more accurately quantify the size and extent of the aneurysm, as well as the relationship to branch vessels. My recommendations for therapy (observation or intervention; open or endovascular repair) will depend on the patient's life expectancy, perioperative risk factors, operative risk, and patient's wishes.

PATIENT CARE

Clinical Thinking

- Complications associated with an aneurysm include rupture, thrombosis, or embolization. The risk of rupture is greatest for aortic aneurysms, while thrombosis and embolization are more commonly associated with peripheral arterial aneurysms.
- In assessing the patient with an aneurysm, it is important to estimate the patient's life expectancy and operative risk. In the patient with aortic (abdominal or thoracic) and/or iliac artery aneurysms, the risk of rupture usually determines the need for intervention. The risk of rupture increases with size and a hx of hypertension or chronic obstructive pulmonary disease (COPD).
- In a patient with an aneurysm, the associated presence of other aneurysms needs to be determined. In patients with an aortic aneurysm, approximately 14% will have a concomitant thoracic

aneurysm. In patients with a popliteal aneurysm, there will be a coexisting aortic aneurysm 25% of the time; popliteal aneurysms are bilateral in 50% of patients.
- The incidence of an aortic aneurysm is increased in any patient with a hx of smoking or with a family hx of aneurysms. The easiest, least expensive radiologic screening study is ultrasonography. This should be obtained in all patients with a family hx of aneurysms, and in male patients with a hx of smoking over the age of 65. If a pulsatile mass is felt during routine physical examination, ultrasonography is also indicated.
- Typically, patients with an aneurysm should be referred to a vascular surgeon once a thoracic or aortic aneurysm reaches 4 cm in size. All peripheral aneurysms should be referred to a vascular surgeon.

History
- It is first necessary to define the presenting context. How and when was the aneurysm initially identified? Was the aneurysm first found during a routine examination or screening study? Has it increased in size since it was first found? Does the patient have symptoms? Has the patient had back, chest, or abdominal pain? Are there any urologic or GI complaints?
- Associated risk factors should be documented. Does the patient have a first-degree relative with an aneurysm (a parent, a sibling)? Does the patient have a hx of smoking, hypertension, or COPD.
- Because associated peripheral vascular occlusive disease can alter the operation and the preoperative workup, it is important to determine if there is a hx suggesting claudication or rest pain.
- In order to assess perioperative risk and to guide preoperative evaluation, the review of systems should focus on pulmonary, cardiac, renal, and neurologic symptoms.

Physical Examination
- A complete physical examination should be performed on every patient with an aneurysm.
- An attempt should be made to estimate the size of the aneurysm based on observation and palpation.
- The carotid, brachial, femoral, popliteal, dorsalis pedis, and posterior tibial pulses should be assessed and documented. While there are many ways to assess or classify a pulse, the simplest characterizes the pulse as absent (0), decreased (1+), or normal (2+).

IMAGING CONSIDERATIONS

➔**Abdominal aortic ultrasonography:** Simple, reliable evaluation of the abdominal aorta. Can be used for yearly follow-up of a small aneurysm.	$250
➔**CT angiography:** Thin cut spiral CT performed during bolus IV contrast injection. No oral contrast is given. 3D reconstructions provide precise and reliable measurements of the aneurysm as well as the status of renal, mesenteric, and iliac arteries. Such measurements are required if endovascular repair is planned.	$1,500
➔**MRA:** Specialized MRI scan during bolus IV contrast (gadolinium) infusion. Primarily shows the aneurysm lumen and not the wall. Helpful in cases of CTA IV contrast contraindication (allergy, renal compromise).	$1,500
➔**Contrast angiography:** Catheter-based, invasive technique rarely used diagnostically. Images show only the *luminal diameter of the aneurysm*.	$2,000

Clinical Entities — Medical Knowledge

Thoracic Aneurysm

Pφ Aneurysmal dilatation of the thoracic aorta may be either saccular or fusiform, and commonly extends distally to involve the abdominal aorta. These aneurysms are classified from I to V based on the extent of aortic involvement (Crawford classification).

TP The typical patient is asymptomatic. Most often, these aneurysms are found while working up another problem (***Patient 1***). When symptoms of rupture occur, patients commonly complain of chest, back, and/or hypogastric pain. Back pain is frequently located between the scapulae.

Dx Dx is based on clinical suspicion or presenting symptoms. In asymptomatic patients, the identification of an abnormality on CXR often leads to a CT scan that demonstrates the presence of a thoracic aneurysm (***Patient 1***).

Tx Tx depends on the patient's operative risk and life expectancy. If the patient has a life expectancy of 5 years or more and the operative risk is acceptable, repair of the aneurysm is typically recommended when it reaches 6.0 to 6.5 cm in diameter. At this point, the operative risk is typically less than the risk for rupture. Operative options consist of open aneurysmorrhaphy or endovascular repair. If the aneurysm is less than 6 cm in diameter, the patient is followed with CT every 6 to 12 months, until the aneurysm reaches 6.0 to 6.5 cm in size, or symptoms develop. **See Sabiston 65, Becker 38.**

Abdominal Aortic Aneurysm

Pφ Dilatation of the abdominal aorta is typically considered aneurysmal when the diameter is twice that of the normal aorta (normal diameter 1–2 cm). Aortic aneurysms are classified as infrarenal or suprarenal based on their relationship to the renal arteries, and may be fusiform or saccular in configuration. The etiology of an abdominal aortic aneurysm is thought to be a multifactorial degenerative process, related to hemodynamic factors, inflammatory and immune mechanisms, genetic predisposition, atherosclerotic disease, and proteolytic processes.

TP A quarter of the patients are symptomatic at presentation (due to rupture or contained rupture) with back and/or abdominal pain radiating to the groin. In the remainder, the aneurysm is discovered incidentally during the course of a workup for another problem, or on physical examination when a pulsatile mass is palpated (***Patient 2***).

Dx The dx is based on a radiologic imaging study (real-time B-mode ultrasonography or CT scan) demonstrating the presence of an aneurysm.

Tx A concise document outlining the management of abdominal aortic aneurysms has been developed by a subcommittee of the Joint Council of the American Association of Vascular Surgery and the Society for Vascular Surgery (J Vasc Surg 2003, 37:1106–1117). Aortic aneurysms can be followed with a yearly CT scan until the diameter reaches 5.5 cm. Aneurysms typically will expand at a rate of approximately 0.2–0.4 cm/year. More rapid expansion, greater than 1 cm/year, warrants repair even if the diameter has not reached 5.5 cm. Once the aneurysm reaches 5.5 cm, the risk for rupture (approximately 5% per year) outweighs the risk for repair. If the aneurysm is infrarenal, either an open aneurysmorrhaphy or endovascular repair can be considered. If the aneurysm is suprarenal, an open repair is undertaken with renal artery revascularization. **See Sabiston 65, Becker 38.**

Popliteal Artery Aneurysm

Pφ A popliteal aneurysm is the most common peripheral arterial aneurysm. The popliteal artery is aneurysmal if the diameter is 2.0 cm or greater or if the diameter is 1.5 times the size of the nonaneurysmal proximal artery. Often, patients with a popliteal artery aneurysm will have a concomitant aneurysm in the contralateral popliteal artery (50%) or abdominal aorta (25%).

TP These aneurysms have a variable presentation. Up to half of the patients are asymptomatic. Symptomatic patients classically present with evidence of distal ischemia involving the leg, forefoot, and/or digits. Acute embolization can result in painful, bluish discoloration of the digits ("blue toe syndrome," ***Patient 3***) or forefoot, while thrombosis can result in a more extensive ischemic process involving the distal leg, as well as the forefoot and digits. In contrast to thoracic and abdominal aneurysms, rarely does the patient present with rupture of the aneurysm.

Dx Dx is often made on the basis of physical examination. Ultrasonic imaging of the aneurysm is used to confirm the dx. Contrast angiography, CTA, or MRA is then performed to define the proximal and distal vasculature prior to reconstruction.

Tx Therapeutic options consist of ligation of the artery proximal and distal to the aneurysm, with bypass grafting, or endovascular placement of an arterial prosthesis. **See Sabiston 65, Becker 38.**

ZEBRA ZONE

a. **Aortic dissection:** This is the most common, catastrophic aortic condition. With dissection there is a separation of the layers of the aortic wall, and the creation of dual-flow lumens in the aorta. Patients may present with pain, rupture, end-organ ischemia, or aneurysmal degeneration. The process typically begins in the thoracic aorta and may then extend distally to the abdominal aorta and iliac arteries. The dissection may obstruct the visceral branches of the abdominal aorta, resulting in mesenteric ischemia, renal failure, or lower extremity ischemia. Transesophageal echocardiography is used to define the origin of the dissection and the extent of thoracic involvement, while CTA or MRA may be used to define the extent of abdominal aortic involvement. **See Sabiston 65, Becker 29.**

b. **Inflammatory aneurysms:** These aneurysms are associated with a significant perianeurysmal inflammatory response. The patients have an elevated sedimentation rate. CTA not only demonstrates the aneurysm, but also a thickened, contrast-enhancing rind that surrounds the aneurysm. These aneurysms typically present with pain (back, flank, groin, perineal), weight loss, or ureteral obstruction. Differentiation between a ruptured aneurysm and an inflammatory aneurysm can be difficult upon initial presentation. **See Sabiston 65, Becker 38.**

Practice-Based Learning and Improvement: Morbidity and Mortality Self-Assessment Form	
Complication	Acute occlusion, femoropopliteal bypass
Type	Technical
Surgery performed	Right, reversed saphenous vein, femoropopliteal bypass, below the knee
Patient's disease	65-year-old man with with a 3.5-cm popliteal artery aneurysm
Presentation	Sudden onset of a cool, pale right lower extremity, with absent dorsalis pedis and posterial tibial pulses and Doppler flow, 3 hours following surgery
Intervention	Reexploration with identification of atherosclerotic debris at the distal anastomosis
Outcome	The distal anastomosis was detached and the debris removed. The graft was declotted and arterial inflow reestablished, after which the distal anastomosis was redone. Following revision, the patient had palpable dorsalis pedis and posterior tibial pulses.
Risk factors	Atherosclerotic vessels with calcification
How were risks addressed?	Completion arteriography was performed and the anastomosis appeared patent.
What happened?	There may have been dislodgement of unstable debris in the common femoral artery at the time of dissection and anastomosis. This debris embolized in the postoperative period.
What could have been done differently?	The dissection of the femoral vessels could have been more meticulous, taking care not to clamp the vessel in an area of calcification or plaque.
Would outcome have been different?	Had there not been graft occlusion, the patient would not have required a second anesthetic and exploration.

Interpersonal and Communication Skills

Discussing Risks and Treatment Options

When discussing aneurysmal disease it is important to be completely honest with the patient regarding the potential risks, complications, and benefits of repair. Because the majority of patients are asymptomatic at presentation, it is critical that the patient understand why aneurysms are repaired, as well as the timing of the repair. When discussing repair options, if both an open operation and an endovascular repair are suitable, elicit the patient's concerns, fears, and wishes to guide his or her decision on the tx strategy.

Professionalism

Commitment to Professional Responsibilities: Sexual Harassment

It is 2 AM. You have just come out of a 4-hour case of a ruptured aneurysm, and you and the team return your patient to the ICU in stable condition. You witness the chief resident put his arm affectionately around one of the medical students. The affection is obviously unwanted.

Sexual harassment has become a national concern and one that is increasingly recognized in the field of medicine. Studies show that female students encounter an unacceptable amount of sexual harassment in medical training from fellow students, patients, faculty, and doctors with whom they work. This behavior affects learning opportunities. Medical educators need to address issues of gender, sexual harassment, and the setting and maintaining of sexual boundaries in order to prevent a hostile learning environment from developing.

Systems-Based Practice

Patient Safety: High-Alert Medications

Patients undergoing vascular surgery typically receive anticoagulant medications. Anticoagulants, such as heparin and warfarin, are considered *high-alert medications*. Other high-alert medications include insulin, opiates, chemotherapeutic agents, and medications used with sedation and anesthesia. Errors involving high-alert medications have a high risk for causing significant harm. Anticoagulants also have characteristics that make errors more likely: dosages vary from patient to patient and are often dependent on laboratory values, which can introduce errors into the prescription process. Unintentionally prescribing multiple anticoagulants can dramatically increase the possibility of complications from bleeding. In the hospital setting, heparin can be confused with look-alike or sound-alike drugs, such as Hespan. Heparin also comes in multiple concentrations—10 units/mL to maintain the patency of IV catheters, 1,000 units/mL for anticoagulation, and 10,000 units/mL. Particular care needs to be taken to correctly prescribe, reconcile, administer, and monitor anticoagulants.

Chapter 36
Cerebrovascular Disease (Case 22)

Iraklis I. Pipinos MD

Patient 1 66-year-old man with right carotid bruit

Patient 2 53-year-old woman with transient left eye blindness

Patient 3 76-year-old woman with a hx of right hand weakness and aphasia lasting 2 hours, with complete resolution

Patient 4 70-year-old man with a 2-day hx of right arm and leg weakness and numbness

In each chapter in this section the Differential Diagnosis box has been replaced by a Framework for Clinical Thinking box to help direct the sorting process. See the editor's note on page 249.

Framework for Clinical Thinking

Patient	Symptom	Timing	Process	Location
1	None	Chronic	Atherosclerosis	Carotid bifurcation
2	Amaurosis fugax	Acute	Atherosclerosis embolic	Carotid bifurcation Heart, proximal great vessels
3	TIA	Acute	Atherosclerosis embolic	Carotid bifurcation Heart, proximal great vessels
4	Stroke	Acute	Atherosclerosis embolic, thrombotic Idiopathic	Carotid bifurcation Heart, proximal great vessels Intracerebral

Note that **Symptom** and **Timing** are reported by the patient. **Process** is an assumption, and **Location** is deduced from that assumption. Process and location need to be verified by physical examination and other appropriate studies.

Speaking Intelligently

When I am asked to evaluate a patient with carotid disease, I first determine whether the patient is ***symptomatic*** or ***asymptomatic***.

Most ***asymptomatic*** patients are referred by their primary care physician, who may have heard a cervical bruit or identified a carotid stenosis following screening ***carotid duplex imaging*** in a patient with multiple atherosclerotic risk factors.

Most ***symptomatic*** patients are referred following a ***transient ischemic attack*** (TIA) or a ***stroke***. TIAs can be classified as ***retinal*** (amaurosis fugax; transient monocular blindness) or ***hemispheric.*** Hemispheric symptoms cover the spectrum of neurological dysfunction. Depending on the region of the brain involved, this usually includes a combination of motor and sensory deficits. By definition, ***TIAs*** last from a few seconds to 24 hours. Deficits that last longer than 24 hours are considered ***strokes***.

It is then important to determine the etiology. One of the most common causes of TIA or stroke is cholesterol or platelet emboli arising from a complicated plaque at the carotid bifurcation or origin of the internal carotid artery. Of the other potential causes of TIA or stroke, ***one third*** will be ***cardiogenic*** (emboli usually resulting from atrial fibrillation or other arrhythmias); ***one third*** will be secondary to small vessel intracranial atherosclerotic disease involving the penetrating arteries supplying the deep white matter (***lacunar infarcts***); and in the remaining ***third,*** the source will not be identified.

PATIENT CARE

Clinical Thinking

- In the patient with ***asymptomatic*** carotid bifurcation disease, three factors are important: degree of stenosis, life expectancy, and operative risk. Patients with a ***60% carotid stenosis or greater,*** a life expectancy ***of 5 or more years,*** and a ***satisfactory operative risk*** should be considered for carotid revascularization. All others should receive maximal medical therapy and regular follow-up for their carotid disease.
- Carotid revascularization encompasses standard ***carotid endarterectomy*** and, in centers of excellence, ***carotid angioplasty*** and ***stenting***.
- Maximal medical therapy involves risk factor modification, including ***smoking cessation*** and optimal and close management of ***diabetes, hypertension, dyslipidemia,*** and ***obesity***. Most physicians also prescribe a ***daily aspirin***.

- In the patient with ***symptomatic*** disease and an ipsilateral internal carotid artery stenosis greater than 50%, carotid revascularization should be considered. Again, carotid revascularization can include standard carotid endarterectomy and, in centers of excellence, carotid angioplasty and stenting. In all other patients, including those with total internal carotid artery occlusion or a stenosis less than 50%, maximal medical therapy is the approach of choice.

History

- The dx of most TIAs is based on hx. It is important to carefully interview both the patient and all other people who were present during the episode because the patient often has minimal recollection of the event.
- It is important to clearly identify deficits relative to the involved cerebral hemisphere or side of the body (i.e., a left hemispheric TIA or a right body TIA).
- Amaurosis fugax is characterized by monocular blindness, often described as a shade coming across the visual field. In obtaining a hx of amaurosis, it is important to confirm that the symptoms were monocular, painless, and transient.

Physical Examination

- Careful documentation of baseline neurological function is very important, both to establish the extent of neurologic deficit and also to provide a basis of comparison for subsequent follow-up.
- In the patient with amaurosis fugax, a fundoscopic examination should be performed to determine whether a cholesterol embolus (Hollenhorst plaque) is present. A Hollenhorst plaque is seen as bright yellow, refractile debris in a branch of the retinal artery.

Tests for Consideration

- **ECG:** Helpful in dx of cardiac arrhythmias and the identification of previous or ongoing myocardial ischemic events. **$150**
- **Transesophageal echocardiography:** Can be used to identify potential embolic sources, including left atrial or ventricular thrombus, a patent foramen ovale, or atherosclerotic involvement of the aortic arch. **$1,000**

IMAGING CONSIDERATIONS

➔**Carotid duplex imaging:** Initial imaging study of choice for extracranial carotid stenosis. The two parts of the duplex examination are real-time imaging of the artery and Doppler analysis of flow. Stenosis is determined by accelerated flow velocity through the narrowed vessel. **$250**

➔**CT angiography (CTA) or MRA:** CTA requires IV contrast; MRA can be performed with or without contrast. When performed properly, CTA provides the optimal preoperative imaging by showing not only the degree of stenosis but also the amount of calcified plaque and atheroma. **$1,500**

➔**Contrast arteriography:** With the advent of CTA and MRA, contrast arteriography is rarely obtained. It may be ordered if the results of carotid duplex imaging and CTA / MRA are not congruent. **$2,000**

Clinical Entities — Medical Knowledge

Asymptomatic Carotid Stenosis

Pφ Asymptomatic stenoses are associated with a stroke risk of approximately 10% to 15% over a 5-year period.

TP The patient (***Patient 1***) is usually referred after a primary care physician has heard a cervical bruit or identified a carotid stenosis on screening duplex imaging obtained because of significant atherosclerotic risk factors.

Dx Diagnostic studies include a combination of ***carotid duplex imaging*** and ***CTA*** or ***MRA***.

Tx Patients with a 60% or greater carotid stenosis, a life expectancy of 5 or more years, and a satisfactory operative risk should be considered for carotid revascularization. Carotid revascularization includes standard carotid endarterectomy and, in centers of excellence, carotid angioplasty and stenting. All others should receive maximal medical therapy and a yearly follow-up duplex examination. **See Sabiston 64, Becker 39.**

Transient Ischemic Attack

Pφ TIAs and strokes resulting from a carotid stenosis are secondary to emboli occluding branches of the distal internal carotid artery (retinal artery, anterior or middle cerebral artery, and/or one or more of their branches). The emboli originate from plaque at the carotid bifurcation and/or the bulb and internal carotid artery. Such emboli are not produced by smooth, fibrous plaques; rather the plaques have ruptured and/or ulcerated, releasing atherosclerotic debris, or have formed platelet clots on their thrombogenic surface that embolize, producing acute occlusion of intracerebral arteries with hypoperfusion of the corresponding brain segment.

TP The patient presents with transient and focal neurologic deficits, lasting less than 24 hours, that can easily be localized (based on the presentation) to a specific cerebral hemisphere.

The typical patient presents with either a retinal TIA (***amaurosis fugax*** = fleeting darkness) or a hemispheric TIA. Amaurosis fugax is classically described as a dark shade coming down over one eye (***Patient 2***).

Right hemispheric TIAs usually include a combination of motor and sensory deficits involving the left side of the face or body. Left hemispheric TIAs usually include a combination of motor and sensory deficits involving the right side of the face or body as well as aphasia (***Patient 3***).

Transient ischemic attacks can be repetitive and stereotypic, suggesting that the embolic debris originates from the same area of the plaque and streams to the same location in the brain.

Dx The dx depends on an appropriate hx, along with the finding of a significant stenosis on ***carotid duplex imaging, CTA,*** or ***MRA***.

Tx In patients with a 50% or greater stenosis of the ipsilateral internal carotid artery, carotid revascularization is strongly considered. Again, carotid revascularization includes carotid endarterectomy and, in centers of excellence, carotid angioplasty and stenting for high-risk patients. In all other patients, including those with a less than 50% stenosis or total internal carotid occlusion, maximal medical therapy is the indicated therapy. **See Sabiston 64, Becker 39.**

Stroke	
Pφ	Similar to that attributed to a TIA.
TP	By definition, a stroke is a neurologic deficit that has persisted for more than 24 hours (***Patient 4***). Deficits are dependent on the involved cerebral territory and are similar to those described for TIAs.
Dx	The dx is dependent on an appropriate hx along with the finding of a significant stenosis (50% or greater) on carotid duplex imaging and CTA or MRA. An MRI or CT of the brain may demonstrate evidence of a hemispheric infarct, corresponding to the patient's presenting symptoms or deficit.
Tx	Optimal medical management of stroke includes an antiplatelet agent, supplemental oxygen, and isotonic volume administration to avoid hypoxia and hypotension. If a patient is hypertensive, care should be taken to avoid aggressive reduction in the blood pressure as this may reduce cerebral perfusion. If the patient presents within 3 hours of the onset of symptoms, and has no contraindications to thrombolysis, *tissue plasminogen activator* should be strongly considered. In the remaining patients, if there is evidence of a greater then 50% stenosis of the ipsilateral internal carotid artery, carotid revascularization should be considered. Most vascular surgeons plan for revascularization 2 to 6 weeks after the onset of symptoms. In all other patients, including those with total internal carotid occlusion or a stenosis less than 50%, maximal medical therapy is the approach of choice. In patients with a massive stroke and associated intracranial hemorrhage, cerebral edema and mass effect, or seizures, medical therapy and possible neurosurgical intervention may be indicated. **See Sabiston 64, Becker 39.**

Vertebrobasilar or Posterior Circulation Disease

Pφ Posterior circulation disease and associated symptoms are much less common than carotid (anterior circulation) disease. Symptoms can be produced by embolization from a proximal plaque or by extrinsic compression/occlusion of the vertebral artery in its bony canal. Emboli usually arise from the origin of the vertebral artery. Symptoms resulting from extrinsic compression are usually recurrent and always positional, associated with neck rotation producing obstruction of the vertebral artery in its osseous canal.

TP Asymptomatic vertebrobasilar disease is usually identified on carotid duplex imaging or CTA/MRA studies performed to evaluate carotid disease. Symptomatic patients usually present with one of the following classic symptoms and signs: motor or sensory deficits that occur bilaterally during the same episode, ataxia, diplopia, dysarthria, and homonymous visual field loss. Vertigo, drop attacks, and tinnitus are compatible with vertebrobasilar ischemia, but by themselves are nondiagnostic.

Dx The dx depends on appropriate hx along with findings of a significant vertebral artery stenosis or obstruction on carotid duplex imaging, CTA, or MRA.

Tx Asymptomatic stenosis of the vertebral artery is considered for repair if it is high grade (>75%), and involves a single dominant vertebral artery or both vertebral arteries in patients with bilateral internal carotid artery occlusion who may require another major operative intervention such as coronary artery bypass grafting. In all other asymptomatic patients, antiplatelet therapy with aspirin and/or clopidogrel is recommended.

For symptomatic patients, with evidence of a high-grade stenosis and embolization, the reconstructive options include vertebral-carotid transposition or endovascular angioplasty with or without stenting. In patients with symptoms due to external compression, the tx of choice is a vein bypass distal to the intraosseus vertebral segment where compression is occurring. **See Sabiston 64, Becker 39.**

ZEBRA ZONE

a. **Fibromuscular dysplasia of the carotid artery:** Fibromuscular dysplasia is a nonatherosclerotic and noninflammatory arteriopathy that primarily affects medium-sized muscular arteries. Its incidence is approximately 1% in the general population. In 90% of cases it affects women in their fourth or fifth decade of life. Angiographically, the involved segment of artery is classically described as having the appearance of a string of beads or a stack of coins. When asymptomatic it should be treated with aspirin or clopidogrel. In symptomatic, good-risk patients, open or endovascular angioplasty is usually the tx of choice. **See Sabiston 66, Becker 39.**

b. **Carotid dissection:** A dissection can be traumatic (after a minor or significant whiplash injury) or most commonly, spontaneous. Patients may present with TIAs or stroke. The dx can be suspected on carotid duplex imaging and is verified with CTA or standard arteriography. The classic arteriographic finding is a tapered stenosis or occlusion of the internal carotid artery beginning a few centimeters distal to the common carotid artery bifurcation. Anticoagulation with heparin, followed by Coumadin for 3 months is the recommended management for these patients. **See Sabiston 72, Becker 39.**

c. **Subclavian steal:** A proximal subclavian artery obstruction may result in flow reversal in the ipsilateral vertebral artery. In these cases, the vertebral artery provides collateral flow to the subclavian and axillary arteries, distal to the stenosis or obstruction, and the patient will have an associated reduction in brachial blood pressure on the affected side.

Editors note: Currently, the treatment of carotid disease is based on the results of two studies, the Asymptomatic Carotid Atherosclerosis Study (ACAS) and the North American Symptomatic Carotid Endarterectomy Trial (NASCET). Because an understanding of the results of these studies is critical to the evidence-based decision-making process in patients with asymptomatic and symptomatic carotid occlusive disease, the decision was made to include both in the Practice-Based Learning and Improvement section of this chapter.

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
Endarterectomy for asymptomatic carotid artery stenosis

Authors
Executive Committee for the Asymptomatic Carotid Atherosclerosis Study

Institution
Multi-institutional study

Reference
Journal of the American Medical Association 1995;273(18):1421–1428

Problem
To determine whether the addition of carotid endarterectomy to aggressive medical management can reduce the incidence of cerebral infarction in patients with asymptomatic carotid artery stenosis.

Intervention
Daily aspirin administration and medical risk factor management for all patients; carotid endarterectomy for patients randomized to receive surgery.

Quality of evidence
Prospective randomized controlled trial of 1662 patients.

Outcome/effect
Asymptomatic patients with carotid artery stenosis of greater than 60% had a decreased incidence of ipsilateral stroke.

Historical significance/comments
This landmark article was the first major trial to demonstrate the superiority of carotid revascularization over medical therapy for asymptomatic patients with greater than 60% stenosis.

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
Beneficial effect of carotid endarterectomy in symptomatic patients with high-grade carotid stenosis.

Authors
North American Symptomatic Carotid Endarterectomy Trial Collaborators.

Institution
Multi-institutional study

Reference
New England Journal of Medicine 1991;325:445–453

Patients
A randomized trial at 50 clinical centers throughout the United States and Canada, involving 659 patients. Patients had had a hemispheric or retinal transient ischemic attack or a nondisabling stroke and had evidence of a 70–99% stenosis in the ipsilateral carotid artery.

Problem
To determine whether the addition of carotid endarterectomy to aggressive medical management can reduce the incidence of cerebral infarction in patients with symptomatic high grade carotid artery stenosis.

Intervention
All patients received optimal medical care, including antiplatelet therapy. Those assigned to surgical treatment underwent carotid endarterectomy performed by neurosurgeons or vascular surgeons.

Quality of evidence
Randomized multicenter trial. End points were assessed by blinded, independent case review. No patient was lost to follow-up.

Outcome/effect
Life-table estimates of the cumulative risk of any ipsilateral stroke at two years were 26% in the 331 medical patients and 9% in the 328 surgical patients—an absolute risk reduction (±SE) of 17 ± 3.5% ($p < 0.001$).

Historical significance/comments
This landmark article was the first major randomized prospective trial to demonstrate the superiority of carotid revascularization over medical therapy for patients with recent hemispheric and retinal transient ischemic attacks or nondisabling strokes and ipsilateral high-grade stenosis (70–90%) of the internal carotid artery.

Interpersonal and Communication Skills

Involving Family in Decisions

Carotid endarterectomy has a low but definite (approximately 2% for asymptomatic and 6% for symptomatic patients) risk for stroke, and the patient needs to carefully consider operative risk against the risk of stroke with medical therapy alone. A decision in which the family is not involved could result in conflict, hard feelings, or medical-legal action should the patient develop an operative complication or stroke on medical therapy. Inadequate communication correlates directly with poorer health outcomes and a disproportionate number of malpractice suits.

Professionalism

Commitment to Improving Quality of Care

The care of patients with carotid disease, especially those who have experienced a TIA or stroke, requires a team approach and specialized expertise. The patient is usually admitted under the care of a neurologist or a physician with a special interest in carotid disease. Interdisciplinary assessment and tx incorporates a team concept and can include a vascular surgeon, neurosurgeon, dietitian, neuropsychologist, occupational therapist, social worker, and speech pathologist. Pharmacy support is provided routinely. Pastoral care services should also be available. The team should maintain a prospectively updated registry as a useful clinical tool for program planning, research, and quality assurance purposes. Finally, development of educational materials to assist the patient and family in their understanding of the disease process and the care provided can be very useful.

Systems-Based Practice

Provider Operations and Coordination

Patients presenting with carotid disease should be treated based on the degree of their stenosis, the presence of symptoms, their life expectancy, and their operative risk. Regardless of the tx option employed, interaction with the patient's primary care physician is important to assure that risk factor modification (smoking, hypertension, dyslipidemia, diabetes, obesity) has been implemented and the patient is treated with an antiplatelet agent. Those patients who are treated with medical therapy should have yearly follow-up with a clinical evaluation to identify possible new symptoms and with duplex ultrasonography as a means of characterizing the progression of any carotid disease.

Chapter 37
Leg Swelling (Case 23)

Jason M. Johanning MD

Patient 1 33-year-old woman with a 2-day hx of left calf pain and swelling

Patient 2 54-year-old man with a 3-year hx of right leg swelling and medial calf ulcer

Patient 3 55-year-old man with left leg swelling 2 years following prostatectomy, pelvic lymph node dissection, and adjuvant pelvic radiation

Patient 4 66-year-old man with bilateral leg swelling and shortness of breath

In each chapter in this section the Differential Diagnosis box has been replaced by a Framework for Clinical Thinking box to help direct the sorting process. See the editor's note on page 249.

Framework for Clinical Thinking

Patient	Symptom	Timing	Process	Location
1	Swelling	Acute	Venous thrombosis Venous obstruction	Vena cava, iliac, femoral, popliteal veins
2	Swelling, ulceration	Chronic	Venous obstruction Valvular incompetence	Vena cava, iliac, femoral, popliteal veins
3	Swelling	Chronic	Lymphatic obstruction, post-surgery and radiation	Ilioinguinal lymphatics
4	Swelling	Chronic	Fluid overload and sequestration	Interstitial tissue (extracellular fluid space)

Note that **Symptom** and **Timing** are reported by the patient. **Process** is an assumption, and **Location** is deduced from that assumption. Process and location need to be verified by physical examination and other appropriate studies.

Speaking Intelligently

When I approach the patient with lower extremity swelling, I consider venous and lymphatic etiologies first. If venous and lymphatic causes are excluded, more generalized systemic etiologies or alternative local factors should be investigated.

Lower extremity swelling of venous etiology results from venous obstruction or valvular incompetence. Thrombotic obstruction of the venous outflow and valvular incompetence with venous reflux result in venous hypertension and edema. Lower extremity duplex imaging can be used to identify both thrombotic occlusion and venous reflux.

Lower extremity swelling may also result from lymphedema. The lymphatics function to return protein, lost from the plasma, back to the circulation. Dysfunction of the lymphatics associated with lymphedema results in the accumulation of protein and fluid in the interstitial tissues. Lymphedema may be primary or secondary in etiology. Primary lymphedema is due to an intrinsic disorder of the lymphatic channels and is generally classified according to the age at onset. Secondary lymphedema is more common than primary lymphedema and results from any process leading to lymphatic damage. Common causes include cancer (tumor, surgery, or radiation), infection, inflammation, or trauma. Lymphoscintigraphy is used to diagnose and localize lymphatic obstruction.

Systemic causes of lower extremity swelling generally result in bilateral lower extremity edema. Congestive heart failure and cirrhosis (liver failure) are common systemic etiologies. Localized trauma or injury is generally associated with unilateral swelling.

PATIENT CARE

History

- Patients should be asked to describe the acuity of onset and the character of any associated pain. Is the swelling unilateral or bilateral? Were there any antecedent events that predated the leg swelling? Patients with chronic venous insufficiency usually have an antecedent event predating the onset of their symptoms: ask about a hx of DVT, long bone fracture, prior surgery. or prolonged immobilization.
- Pain experienced by a patient with leg swelling can have specific qualities based on the underlying pathology: ***DVT***—a dull ache aggravated by ambulation and improved with elevation; ***superficial thrombophlebitis***—localized pain overlying the area of thrombosis; ***lymphedema***, in general, is painless unless associated with a superimposed cellulitis.

Physical Examination

- The examination begins with observation. In patients with venous obstruction, the location of the swelling will often indicate the level of obstruction. Calf and leg swelling generally indicate an occlusive process involving the femoral or popliteal veins. Swelling of the entire extremity, including the thigh, suggests an iliofemoral obstructive process.
- It is important to objectively quantify the extent of swelling, which can be done by measuring the diameter of the leg below the tibial tuberosity and above the malleoli.
- The type of edema should be documented. Venous disorders will produce pitting edema whereas the swelling associated with lymphedema is nonpitting. Toe and foot swelling is almost exclusively found in patients with lymphedema.
- Skin changes should be noted. Chronic venous skin changes are generally associated with deep venous incompetence and include lipodermatosclerosis and ulceration in proximity to the medial malleolus. Superficial venous insufficiency usually results in serpiginous varicosities involving the thigh, calf, and ankle with a distribution related to the origin of the reflux.
- Ulceration is a common late finding of deep venous insufficiency. Rarely will the patient have venous ulceration from isolated superficial venous insufficiency; however, it is common for both deep and superficial venous insufficiency to coexist.
- Superficial thrombophlebitis usually presents as a localized area of erythema and induration.
- Assessment of the pulse status is critical, as many patients will have coexisting arterial occlusive disease. As it may be difficult to palpate pulses because of the swelling, a Doppler examination should be used to confirm the presence and character of the flow. If there is any question about arterial inflow, ankle-brachial indices should be obtained.

IMAGING CONSIDERATIONS

→**Duplex imaging:** Doppler and real-time ultrasonography of the veins is the initial diagnostic study for patients with leg swelling. The deep, superficial, and perforating veins can be imaged. Color flow Doppler can "see" flow in the vein particularly when augmented by squeezing the calf or a Valsalva maneuver. The lumen can be compressed by the ultrasound probe if there is no obstructing thrombus. **$250**

→**Venography:** An invasive contrast study using a dorsal vein of the foot and tourniquets to image the veins of the leg. Rarely used. **$1,500**

→**CT venography (CTV)/MR venography (MRV):** Noninvasive cross-sectional imaging recreates 3D views. Primarily used as a problem solver rather than for routine evaluation. Advantageous when intra-abdominal processes cause venous compression, which are then easily seen on the cross-sectional images. **$1,500**

→**Lymphoscintigraphy:** The injection of radiolabeled dye into the web space between the toes allows imaging of lymphatic flow, localizing the level of obstruction. Lymphoscintigraphy is usually reserved for those patients where the dx of lymphedema is in question. **$1,000**

Clinical Entities — Medical Knowledge

Acute Deep Venous Thrombosis

Pφ Acute thrombotic obstruction of the deep veins of the lower extremity results in venous stasis/pooling and elevated venous pressures distal to the obstruction. Typical patterns are iliofemoral, involving the iliac and femoral veins, and femoropopliteal venous thrombosis.

TP The typical patient (***Patient 1***) presents with lower extremity swelling, primarily in the calf, which increases with ambulation and improves with rest and elevation. The patient will often report an antecedent event or predisposing condition such as recent surgery, trauma, travel, prolonged immobilization, or a dx of cancer. On physical examination, the circumference of the extremity will be significantly increased (>2 cm) compared with the uninvolved extremity.

Dx The acute onset of leg swelling with evidence of acutely obstructing deep venous thrombus (DVT) on ***lower extremity venous duplex imaging*** is diagnostic.

Tx Therapy consists of therapeutic anticoagulation with heparin and Coumadin. Local symptoms are controlled by elevation of the extremity. The leg is wrapped with compression bandages and the patient is allowed to ambulate. With the control of acute swelling, compression bandages can be replaced with graduated compression stockings. If the patient has iliofemoral venous thrombosis, thrombolytic therapy may be an option in the patient without a prior hx of DVT and the recent (within 7 days) acute onset of symptoms. **See Sabiston 68, Becker 36.**

Superficial Thrombophlebitis (Acute Superficial Venous Occlusion)

Pφ Thrombosis of the superficial veins results in localized inflammation surrounding the affected veins. As opposed to deep venous obstruction, venous hemodynamics in the lower extremity are not usually affected.

TP The patient typically presents with a painful, erythematous, area of induration involving the medial aspect of the thigh or calf. The patient will usually have associated varicosities that may also be involved. No specific position or activity makes the pain better or worse. Ambulation is usually not significantly affected.

Dx The dx is made by identifying a palpable cord in proximity to the area of induration and erythema. The dx is confirmed by documenting occlusion of a superficial vein or varicosity using ***lower extremity venous duplex imaging***.

Tx The tx of superficial thrombophlebitis consists of nonsteroidal anti-inflammatory agents, rest, elevation of the affected extremity and warm moist compresses over the affected area. **See Sabiston 68, Becker 36.**

Chronic Deep Venous Insufficiency

Pφ Chronic venous insufficiency (venous stasis ulceration, post-phlebitic syndrome) is frequently a result of the venous valvular dysfunction that follows DVT. Because symptoms develop 5 to 10 years after an episode of DVT, the patient may not recall the initial event. As a result, the patient should also be questioned about a prior hx of predisposing risk factors, such as long bone fracture, pelvic surgery or prolonged immobilization. Symptoms progress from mild swelling to induration and lipodermatosclerosis (a brownish discoloration and induration due to fibrosis of the subcutaneous tissues and hemosiderin deposition), and ultimately to ulceration. Ulceration is most common over the medial leg.

TP In patients with chronic deep venous insufficiency, there can be significant swelling and edema. Lipodermatosclerosis and ulceration may be present at the level of the medial malleolus (***Patient 2***). Patients complain of pain and heaviness, generally worse at the end of day, with associated swelling.

Dx The dx of deep venous insufficiency and venous reflux is confirmed with ***lower extremity venous duplex imaging***. In a significant number of patients where symptoms are mild to moderate, venous reflux may not be documented on duplex examination, but may be assumed. If necessary, venography may be used to confirm the dx, but generally the findings will not alter the therapy.

Tx Tx of chronic venous insufficiency consists of conservative measures, including the use of elevation and graduated compression stockings. If ulcerations are present, medicated compression wraps (Unna's boot) are usually employed. The results of surgical repair, attempting to restore valve function, have generally been dismal. **See Sabiston 68, Becker 35.**

Superficial Venous Insufficiency (Varicose Veins)

Pφ Superficial venous insufficiency is due to incompetent valves at the saphenofemoral junction and within the greater saphenous vein. This condition may be hereditary and frequently follows childbirth. The valve dysfunction results in an enlarged saphenous vein with the development of subcutaneous varicosities, spider veins, and telangectasias.

TP The patient will complain of varicosities associated with pain, heaviness, and an aching sensation involving the leg. Swelling is usually minimal, but if present is worse at the end of the day. Elevation of the legs generally provides symptomatic relief.

Dx ***Lower extremity venous duplex imaging*** can also be used to confirm saphenous or perforator vein incompetence. Clinically, the Trendelenberg test can be used to identify saphenous-dependent varicosities. Prompt refilling of the varicosities on standing suggests the presence of incompetent perforating veins.

Tx Tx of superficial venous (saphenous or perforating vein) reflux and varicosities is based on the elimination of valvular incompetence and venous reflux. Tx options include saphenous vein stripping or endovenous ablation, perforation ligation, and stab phlebectomy. **See Sabiston 68, Becker 35.**

Primary Lymphedema

Pφ Primary lymphedema results from an intrinsic abnormality of the lymphatic system. It is classified relative to the age at onset. ***Congenital lymphedema*** presents at birth and is more common in males. ***Lymphedema praecox*** is the most common form and presents at the onset of puberty. ***Lymphedema tarda*** generally presents in patients over 35 years of age. Lymphedema praecox and lymphedema tarda affect women more commonly.

TP The clinical presentation is usually associated with painless leg swelling or mild discomfort. The presentation is usually unilateral, and elevation of the extremity generally does not result in resolution of the edema. As the disease progresses, the extremity develops a spongy, firm consistency. Ulcerations are rare, although recurrent episodes of cellulitis can occur.

Dx Dx is usually based on hx and physical examination. ***Lower extremity venous duplex imaging*** is obtained to rule out any deep venous abnormalities. Lymphoscintigraphy is obtained when there is a question regarding the etiology of the swelling.

Tx Tx of primary lymphedema is usually directed at conservative measures, including prevention of skin infection and massage therapy to reduce the interstitial fluid component. Aggressive tx of infections in these patients is necessary, and often a prescription (antibiotic coverage for gram-positive organism) is given to the patient to take at the first sign of infection. This is to prevent scarring of the lymphatics related to infection. Compression therapy is the mainstay of tx, which is usually instituted after the patient has undergone manual lymph drainage in the form of either physical therapy massage or mechanical compressive therapy. **See Sabiston 69, Becker 35.**

Secondary Lymphedema

Pφ Secondary lymphedema is most commonly seen in foreign countries, or following foreign travel, and is primarily caused by infection (filariasis). The most common causes in the United States result from injury to, or removal of, regional lymph nodes (***Patient 3***). Specific causes of secondary lymphedema include cancer (tumor, surgery, or radiation), infection, inflammation, or trauma.

TP The patient presents with swelling and heaviness of the affected limb. Often the patient will present with erythema and cellulitis superimposed on the lymphedema.

Dx The dx of secondary lymphedema is usually made by hx and physical examination, combined with a prior hx of trauma or infection involving the lymphatics. Lymphoscintigraphy is reserved for those cases where the dx is in question.

Tx The tx of secondary lymphedema is nonsurgical with the focus on controlling swelling and the incidence of cellulitis. Patients who have infections and cellulitis should be treated aggressively with antibiotics. **See Sabiston 69, Becker 35.**

Systemic Causes: Congestive Heart Failure, Liver Failure, Renal Failure

Pφ The common theme among systemic causes of lower extremity swelling is fluid overload or fluid retention. The most common cause of bilateral lower extremity swelling is cardiac dysfunction and congestive heart failure (CHF) (***Patient 4***). Often the first manifestation of CHF is progressive swelling of the legs. The swelling associated with CHF, unlike that seen with venous disorders, is generally not affected by leg elevation and is present upon awakening in the morning. It may also be associated with dyspnea and orthopnea.

TP The typical patient may have preexisting disease, although peripheral edema can be the initial presentation of CHF, liver failure, or chronic renal insufficiency. It may also be seen in poorly compliant patients, with a hx of preexisting disease.

Dx Dx is clinical and can be based on echocardiography or laboratory studies.

Tx While support stockings can be helpful in controlling lower extremity swelling, tx should be focused on the underlying etiology. **See Sabiston 69, Becker 35.**

ZEBRA ZONE

a. **May-Thurner syndrome:** May-Thurner syndrome is related to stenosis or obstruction of the left common iliac vein as it crosses under the right common iliac artery. It is seen in young female patients, especially around the time of childbirth when the uterus compresses the left common iliac vein. Patients generally present with unilateral swelling of the left lower extremity that is aggravated by exercise and activity. It is generally worse at the end of the day. Dx can be confirmed by ***venography***, CTV, or MRV. Tx consists of angioplasty and stenting of the obstructed segment of the vein.

b. **Phlegmasia alba dolens (milk leg of pregnancy), phlegmasia cerulea dolens, venous gangrene:** These conditions represent a spectrum of complications following venous thrombosis that ultimately result in tissue ischemia secondary to venous outflow obstruction. ***Phlegmasia alba dolens*** (pain, edema, and pallor of the leg) occurs when the major veins of the affected extremity are occluded with preservation of outflow through venous collaterals. In ***phlegmasia cerulea dolens*** (pain, edema, and cyanosis), the venous collaterals become occluded and venous outflow is progressively compromised. The affected extremity begins to sequester fluid in the interstitium, and massive swelling ensues. Venous gangrene results when phlegmasia cerulea dolens progresses untreated. Tx consists of elevation and anticoagulation with heparin. Surgical thrombectomy is a tx option for patients with phlegmasia cerulea dolens, where the goal is to restore venous outflow as expeditiously as possible. **See Sabiston 68, Becker 36.**

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
The diagnosis of deep venous thrombosis. Fallibility of clinical symptoms and signs

Authors
Cranley JJ, Canos AJ, Sull WJ

Reference
Archives of Surgery 111(1), January 1976

Problem
How accurate is clinical suspicion for DVT?

Intervention
Venography was performed in patients with clinically suspected DVTs.

Quality of evidence
Prospective nonrandomized study of 124 patients

Outcome/effect
Venographic studies demonstrated that clinical symptoms, alone, have a low sensitivity for the presence of DVT. Only 54% of suspected DVTs were confirmed by venography, and 46% had no evidence of DVT.

Historical significance/comments
This article confirmed the need for diagnostic testing to document the presence or absence of DVT. Today, duplex ultrasonography has replaced venography as the initial test of choice for documenting DVT.

Interpersonal and Communication Skills

Effective Listening
Unfortunately, the treatments of many of the underlying conditions that cause leg swelling are relatively limited, and surgical outcomes are either poor or recurrence rates are high. The patient should be informed that very few surgical treatments are available and that lymphedema and chronic venous insufficiency are lifelong conditions treated primarily with compression and supportive care.

At times, "listening" is the most important aspect of your interaction with the patient who presents with a hx of lower extremity swelling. Effective listening includes the following skills:

1. Maintain eye contact with the patient.
2. Observe body language and listen between the lines.
3. Mentally organize useful information in order to stay focused on the patient (rather than continuing to jot notes).
4. Let the patient finish responding before asking additional questions.

Professionalism

Commitment to Maintaining Appropriate Relations with Patients
As conditions that result in significant leg swelling are often associated with perceived and/or actual cosmetic deformity, patients are frequently anxious, frustrated, and persistent in seeking solutions. They may already have seen multiple physicians and may be perceived to be "doctor shopping." Physicians should seek to understand and be tolerant of such behavior. The optimal patient encounter in this circumstance is one in which the physician gives appropriate and detailed information in a caring and supportive environment, leaving enough time to answer all questions.

Systems-Based Practice

Reimbursement: How Hospitals Get Paid

Your patient has a DVT. Was it the primary admitting dx or a postoperative complication? Reimbursements to the hospital will be different based on the patient's admission dx. Whereas years ago hospitals would assemble a list of all of the services provided, and insurance companies would pay for them, this is not usually the case today. Hospitals typically get paid in one of three ways. The most common is a *case payment*, where the hospital receives a fixed amount of money for the patient's entire stay. The amount is dependent on the dx of the patient and does not factor in the specifics of their individual case, unless length of stay is exceptionally long.

Another way hospital reimbursement is made is with *per diem* payments, where the hospital receives a certain amount of money for every day that the patient is in the hospital. Finally, some hospitals participate in a *capitation* payment structure, in which they receive a fixed amount of money per member per month to provide care for a group of patients. The hospital receives this money whether or not the patients are actually admitted to the hospital. As a result, the hospital and the entire health system have an incentive to keep patients healthy and out of the hospital.

If you have had the opportunity to evaluate a patient with vascular disease, you are encouraged to review your patient's course in the context of the Competency Self-Assessment Form on page 35. The form can also be found as a Word document on the book's Web site at www.studentconsult.com, from which is can be printed or downloaded for building your patient-encounter portfolio.

Professor's Pearls: Vascular Surgery

Section Review

Consider the following clinical problems and questions posed. Then refer to the professor's discussion of these issues.

1) A 56-year-old man presents with a hx of left buttock and thigh discomfort after walking two blocks. If he stops and rests, the symptoms resolve in 2 to 3 minutes. The patient describes the discomfort as cramping in character. It has been present for 4 to 6 months and there has been no change in the patient's exercise tolerance.

- Based on the presentation can you determine if the patient has an aortoiliac or femoropopliteal obstruction?
- Would your dx be influenced by the following? (1) you learn that the patient has diabetes, hypertension, and hyperlipidemia; (2) you determine that the patient has a 2+ femoral pulse and an absent popliteal pulse.

2) A 65-year-old woman presents following the onset of right calf and foot pain 2 hours ago. She denies any prior hx of claudication. On physical examination, the right foot is pale in appearance and cool to touch. The popliteal and tibial pulses are absent. There is decreased sensation over the distal leg and foot. She has decreased motion when asked to move the toes or dorsiflex the foot.

- Based on the hx, can you determine whether the patient has an embolic or a thrombotic obstruction?
- Is your dx altered if you subsequently learn that the patient is taking Coumadin for atrial fibrillation?

3) A 72-year-old man presents with a 2-year hx of left calf weakness after walking one block. The symptoms have been present for 2 years but have gotten worse over the past 3 months. The weakness resolves if the patient stops and rests. The patient has a hx of hypertension, smoking, and diabetes.

- Based on the hx, can you determine the etiology of the patient's symptoms?
- Would your dx be influenced by the following? (1) you learn that that the patient has had a lumbar laminectomy; (2) on physical examination, the patient has a palpable left femoral pulse; the left popliteal, dorsalis pedis, and posterior tibial pulses are absent; and the ankle-brachial index on the left is 0.5.

4) A 62-year-old man presents with a hx of pain involving the left forefoot and digits. He has a 2-year hx of claudication, which occurs after one block. Two years ago he could walk five to six blocks before having to stop and rest. Risk factors include hypertension and hyperlipidemia. He has smoked one pack of cigarettes a day for 20 years.

- Based on the hx, do you have enough information to make a dx of rest pain?
- Would your dx be influenced by the following? (1) the patient has a 10-year hx of insulin-dependent diabetes mellitus. (2) On physical examination, the femoral and popliteal pulses are 2+ bilaterally. The dorsalis pedis and posterior tibial pulses are absent bilaterally. The ankle-brachial index is 1.65 on the left. (3) The patient tells you that the symptoms are worse at night. He cannot find a comfortable position, and often walks about his room, without any improvement in symptoms.

5) A 49-year-old man presents with a nonhealing ulcer on the plantar aspect of the right foot. He is a juvenile-onset diabetic on insulin. He also has a hx of hypertension. On physical examination, the patient has a 2-cm ulcer on the plantar foot, subjacent to the first metatarsal phalangeal joint. The right femoral and popliteal pulses are 2+, and the dorsalis pedis and posterior tibial pulses are absent.

- Based on the information provided, can you determine the etiology of the ulcer?
- Would your dx be influenced by the following? (1) The ankle brachial index is 1.69 on the right. (2) On physical examination, there is no palpable bone in the base of the wound. (3) Further studies demonstrate a $TcPO_2$ value of 50 mmHg on the dorsum of the foot; the toe pressure is 45 mmHg. A radiograph of the foot demonstrates no evidence of osteomyelitis.

6) A 65-year-old man presents with a left cervical bruit. He has a hx of claudication, limiting at two blocks, and is treated for hypertension and hyperlipidemia.

- Based on the information provided, can you determine the significance of the bruit?
- How does the following information influence your clinical reasoning? (1) On physical examination, the carotid pulses are 2+ bilaterally. There is bruit heard in the left neck, which is maximal in the mid-neck and radiates to the mandible. It is absent at the base of the neck. (2) The patient is sent for carotid duplex imaging, which demonstrates a greater than 70% stenosis of the left internal carotid artery.
- Based on the information provided, can you determine whether to recommend surgery?

7) A previously healthy 46-year-old man presents with a 2-day hx of left leg swelling and pain. The symptoms developed acutely after he returned from vacation. On physical examination, the left calf has a circumference 3 cm greater than that on the right. The thigh is not swollen. The leg does not appear discolored.

- Based on the information provided, can you say that the patient's symptoms are diagnostic of an acute deep venous thrombosis (DVT)?
- Based on the hx can you determine whether to begin anticoagulation?
- What risk factors predispose to DVT, and what might be a risk factor in this patient?
- Duplex imaging demonstrates evidence of thrombus involving the left femoral and popliteal veins and the patient is anticoagulated. Can you determine whether the patient will develop post-phlebitic complications?

Discussion by Thomas G. Lynch, MD, Professor of Surgery, University of Nebraska School of Medicine

Answer 1

The hx suggests claudication. The symptoms are exercise induced and resolve promptly when the patient stops and rests. The location would suggest a proximal obstructive process, as an aortoiliac obstruction is most likely to result in symptoms in the more proximal of the muscle groups (i.e., the buttock and thigh). Risk factors such as diabetes, hypertension, or hyperlipidemia have little influence on the clinical decision process as it relates to the level of disease in this patient. Risk factors can influence the development of disease at any level. Based on the hx, you would expect an absent left femoral pulse. If the pulse is present, it is less likely that the patient has aortoiliac disease. You should reconfirm the hx and repeat the physical examination. Spinal stenosis should also be considered as an alternate dx.

Answer 2

By hx the patient has had the acute onset of symptoms. Since the distal leg and foot are involved and the popliteal and tibial pulses are absent, this would suggest either a thrombotic or embolic occlusion of the superficial femoral or popliteal artery. Because the patient does not have a prior hx of claudication, significant underlying atherosclerosis of the femoral or popliteal artery and subsequent thrombosis are unlikely. The hx of anticoagulation for atrial fibrillation should increase the likelihood that this is an embolic occlusion.

Answer 3
The patient's hx is suggestive of a vascular etiology. The symptoms occur with walking and are relieved with rest. Even though the patient complains of weakness, it is less likely that this is spinal stenosis. The symptoms of spinal stenosis would be variable in onset. Relief would not occur promptly with rest. While the patient has had a prior lumbar laminectomy, the likelihood of spinal stenosis is still low, based on the hx. The physical examination and vascular laboratory studies would support a vascular etiology, not a neurogenic cause.

Answer 4
The patient presents with pain involving the left forefoot and digits. The prior hx of progressive claudication would suggest a vascular etiology. The risk factors would also predispose to vascular disease. The hx of diabetes and apparent involvement of the distal popliteal and tibial arteries should increase your suspicion of vascular disease, but should also raise the possibility of a diabetic neuropathy. The artifactual elevation of the ankle-brachial index is also consistent with diabetic medial calcification. Based on the information so far, the possibility of rest pain cannot be excluded; however, the fact that the symptoms do not improve with dependency should increase the likelihood that this is not rest pain, but rather neuropathic pain.

Answer 5
Any patient presenting with a nonhealing plantar ulcer could have one or more potential etiologies, including neuropathy, ischemia, or osteomyelitis. The location over a plantar prominence, a hx of diabetes, and a pulse pattern suggesting distal popliteal or tibial occlusive disease would certainly suggest diabetic neuropathy. However, ischemia and osteomyelitis cannot be r/o. The ankle-brachial index is not helpful, as the value is artifactually elevated. While bone in the wound would strongly suggest osteomyelitis, the absence of palpable bone does not exclude it.

Normal $TcPO_2$ values and toe pressures suggest that there is adequate circulation to heal a wound; a negative radiograph would exclude obvious osteomyelitis. Based on the data, the wound should be treated initially as a neuropathic ulceration. If it does not respond to the unloading of pressure from the area of ulceration, the vascular status should be reevaluated and an MRI ordered.

Answer 6
Cervical bruits may be transmitted from the chest or secondary to carotid disease. Carotid bruits are generally maximal in the mid-neck and radiate to the mandible. This bruit is most likely carotid, as it is not heard at the base of the neck. A bruit is the result of wall vibrations secondary to turbulent flow. Turbulence can be associated

with hemodynamically insignificant disease (<50% stenosis) or high-grade stenosis (>70%). Stenoses greater than 90% may actually not be associated with a bruit. As the cross-sectional area of an artery decreases, velocity increases in order to maintain constant flow. The increased flow is associated with turbulence. At a critical point flow and velocity actually decrease, and without increased flow velocity there may no longer be turbulence. At best a bruit is a marker of atherosclerosis. In order to make a recommendation for therapy, it is essential to know the degree of stenosis. Tx options then depend on whether the patient is symptomatic (NASCET Trial) or asymptomatic (ACAS Trial). In applying the results of either trial, it is essential to consider the age of the patient, life expectancy and medical risk factors that may influence the operative morbidity and mortality, and the operative morbidity and mortality of the surgeon performing the operation. Do not uniformly apply published data; it is necessary to know the skills of the local surgical team.

Answer 7

The patient is previously healthy and presents following the acute onset of left leg swelling. The swelling is confined to the calf. The symptoms should certainly raise the suspicion of a DVT. Unfortunately, a DVT cannot be diagnosed on clinical symptoms alone. A systemic etiology is unlikely, as the symptoms are unilateral. The possibility of other causes of pain and swelling, however, such as trauma/injury/strain, superficial thrombophlebitis, hematoma, or dermatitis/cellulitis, cannot be excluded. Prior to tx the dx should be confirmed using duplex imaging. Risk factors for DVT can include obesity, recent myocardial infarction, long bone fracture, immobilization, cancer, and hormonal therapy. In this case, the patient just returned from a vacation, and the possibility of a long airplane flight or car trip should be explored.

It is not uncommon for veins to recanalize following thrombosis. Valvular function, however, is generally not retained. Venous reflux can predispose a patient to post-phlebitic complications. These commonly present 5 to 10 years following a DVT, and symptoms can include swelling, induration, and ulceration. Post-phlebitic swelling should be controlled with graduated compression stockings to reduce the complications associated with the post-phlebitic syndrome.

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Chapter 38
Radiology Tools in the Diagnosis of GI Hemorrhage

John F. Schilling MD *and Anton Mahne* MD

Patients presenting with acute GI hemorrhage may have an upper *or* lower GI bleeding site. Upper GI hemorrhage is usually diagnosed with an upper GI endoscopy, which allows for therapeutic intervention during the study.

Nuclear medicine ***tagged* red blood cell (tagged-RBC) *scans*** are commonly used to evaluate patients presenting with a lower GI hemorrhage, especially in patients with slow or intermittent bleeding. The patient's own red blood cells are labeled with technetium 99m and are reinjected into the patient (Fig. 38-1). Dynamic images of the abdomen are obtained in the anterior view. In a positive study, a focus of abnormal radiotracer activity may initially appear in the abdomen, which represents the bleeding site. As the study continues, and if the bleeding persists, radiotracer activity may be seen moving in an antegrade and/or retrograde direction, due to bowel hyperactivity.

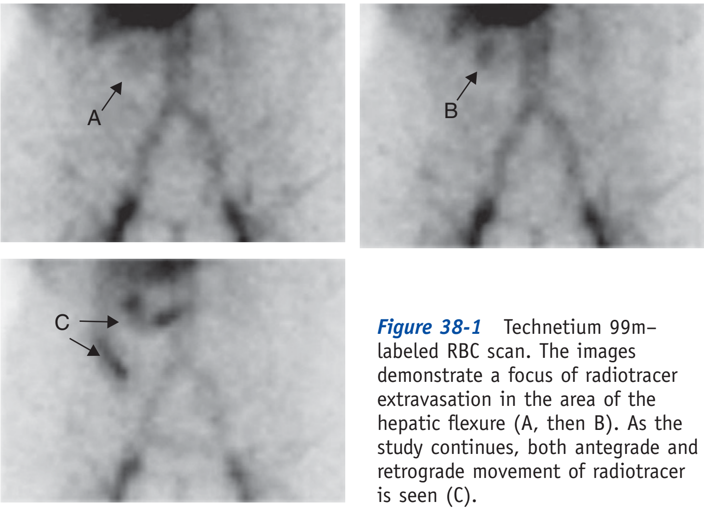

Figure 38-1 Technetium 99m–labeled RBC scan. The images demonstrate a focus of radiotracer extravasation in the area of the hepatic flexure (A, then B). As the study continues, both antegrade and retrograde movement of radiotracer is seen (C).

When a tagged-RBC scan is positive, **angiography** should be performed to localize the site of bleeding, with the potential for therapeutic intervention (Fig. 38-2).

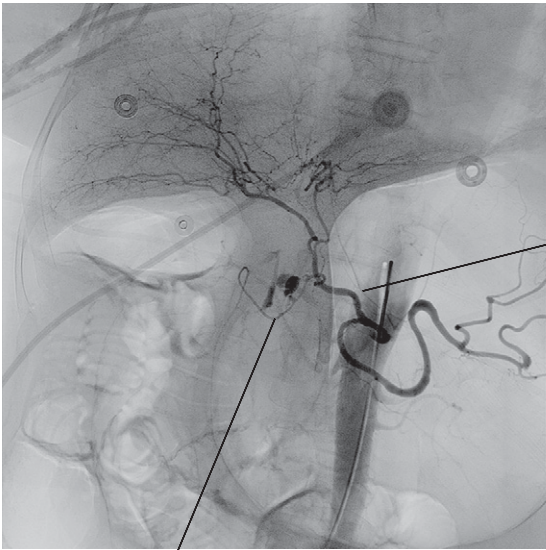

Figure 38-2

Chapter 39
Upper GI Bleeding in a 58-Year-Old Male (Case 24)

Veeraiah Siripurapu MD *and Robert B. Noone, Jr.* MD

Differential Diagnosis

Gastric ulcer/erosion	Duodenal ulcer	Gastritis
Esophageal varices	Mallory-Weiss tear	Gastric neoplasm

Speaking Intelligently

When I'm asked to see a patient with GI bleeding, I begin with resuscitation first. I follow the *ABC's*, protect the airway from aspiration, obtain *large bore IV access,* and *administer volume* (crystalloid 3 : 1 for blood). I consider *central monitoring with a central venous pressure (CVP) catheter,* and I place a *Foley catheter for monitoring urine output*. I insert an *NG tube* for *gastric lavage* (if bloody, approximately 93% predictive of upper GI source), remembering that a duodenal site of bleeding may still be possible with a negative gastric lavage.

Endoscopy is the initial diagnostic test and may be therapeutic. The three most popular methods to achieve hemostasis via endoscopy are injection therapy, coaptive coagulation, and laser phototherapy. The need for surgical intervention and timing will depend on endoscopic findings.

PATIENT CARE

Clinical Thinking

- When suspecting a GI bleed, ask yourself, is this an *upper* or a *lower* GI bleed? An upper GI bleed is defined as proximal to the *ligament of Treitz*. Upper GI bleeding is four times as common as lower GI bleeding. While evaluating the source of bleeding, remember to stabilize the patient.

History

- Explore the bleeding hx: Is there frank bloody emesis, coffee ground emesis, melanotic stool, or hx of chronic anemia?
- Is there associated abdominal pain?
- Explore the past medical hx with attention to the differential:
  - Find out about a hx of *NSAID* use or *Helicobacter pylori* infection.
  - Alcohol abuse or other conditions that cause cirrhosis (HepC / Hep B/ genetic conditions) could result in varices.
  - Forceful emesis or sharp thoracic pain could suggest a Mallory-Weiss tear.
  - Early satiety or weight loss may be a clue to a cancer dx.
- Note that *melena* (70%) and *hematemesis* (50%) are the most obvious presentations of the upper GI bleed; other symptoms include *epigastric pain* (40%), *presyncope* (40%), *heartburn* (20%), and *weight loss* (10%).

Physical Examination

There is no definitive trademark sign that suggests an etiology for upper GI bleed; the following findings may suggest a disease process:

- *Inspection*: Is the patient thin or malnourished (think cancer/alcohol) or jaundiced, or are there stigmata of chronic liver disease such as spider angiomas, asterixis, or clubbing (think cirrhosis with varices)?

- Abdominal scars may suggest past gastric or aortic surgery.
- *Palpation:* Assess for epigastric tenderness. Is the liver edge palpable or nodular? Always examine for lymphadenopathy. Supraclavicular adenopathy (*Virchow's node*) or periumbilical adenopathy (*Sister Mary Joseph's nodule*) may be a sign of advanced gastric cancer.

PATIENT CARE

Tests for Consideration

- **CBC:** Hemoglobin and platelet count **$35**
- **BUN/creatinine:** A ratio >36 in the absence of renal failure is suggestive of upper GI bleeding **$45**
- **LFTs:** May give an idea of hepatic cirrhosis **$65**
- **Amylase/lipase:** Elevated with pancreatitis and intestinal perforation **$25**
- **PT/INR/PTT:** Check for coagulopathy: medication related or from hepatic failure. **$55**
- **Type and cross-match:** Blood needs to be available for resuscitation. [Note: Transfusion requirement is a criterion for surgical intervention and a risk factor for mortality (>5 units = 57% likelihood of surgery, 43% risk of mortality).] **$68**

IMAGING CONSIDERATIONS

→**Barium swallow/upper GI study:** Can show erosive esophagitis, gastric mass, or peptic ulceration. May be able to show esophageal varices. *Has largely been replaced by upper endoscopy*. **$500**

Clinical Entities — Medical Knowledge

Peptic Ulcer Disease

Pφ Peptic ulcer disease is caused by a hyperacidic state or by weakened mucosal defenses; usually associated with the presence of *helicobacter pylori* bacteria.

TP Both gastric and duodenal ulcers are likely to present with melena, hematemesis, and/or epigastric pain. Duodenal ulcers are most common, but incidence of bleeding identical for either. Arterial erosion in ulcer base with vessel greater than 1.5 mm increases mortality.

Dx Endoscopy findings. Biopsies performed to rule out malignant potential. Obtain *H. pylori* titers/biopsy sample to initiate medication if so required.

Tx 80% of ulcer bleeds will stop spontaneously. Endoscopic therapy with injection, heater probe, bipolar cautery, or clip application may be effective. Proton pump inhibitors used as adjunct for active healing and prevention. Rebleeds can be treated with endoscopy, but failure of such demands surgical intervention. Choices would be selective vagotomy, vagotomy and pyloroplasty, or vagotomy and antrectomy. Choice depends on speed with which operation can be performed, stability of patient, rate of recurrence, and experience of the surgeon. **See Sabiston 46, Becker 26.**

Variceal Bleeds

Pφ Increased portal vein pressure greater than 10 mmHg defines portal hypertension. Varices arise from the diverted flow to portosystemic shunts. A shunt through the coronary vein/esophageal submucosal plexus off the portal vein results in esophageal varices. 50% bleed at some point in a patient's lifetime, with a mortality rate of 30% to 50%. Patients with normal liver function have better survival rates. Four recognized collateral sites from the portal vein are (1) esophageal submucosal plexus, (2) coronary vein of stomach, (3) retroperitoneal-umbilical system, and (4) the hemorrhoidal system.

TP Typically painless hematemesis. May present as a massive hemorrhage with signs of shock, necessitating aggressive resuscitation.

Dx Dx is by endoscopy in a patient with a clinical suspicion of cirrhosis.

Tx Tx is broadly summarized as (a) pharmacologic therapy, (b) endoscopic therapy, (c) tamponade, (d) decompressive therapy (radiological, surgical), and (e) liver transplantation. The modalities include:

a. IV vasopressin, terlipressin, or somatostatin or one of its analogs.
b. Endoscopic banding versus sclerotherapy with ethanolamine or polidocanol. Recent meta-analysis found banding therapy to be more favorable than sclerotherapy.
c. Sengstaken-Blakemore or Minnesota tubes. Esophageal and gastric balloons that are inflated to compress varices. *Use of these has steadily declined due to a high complication rate* (20%), including aspiration, perforation, and mucosal necrosis.

d. Radiological shunt. Transjugular intrahepatic portosystemic shunt (TIPS). An intraparenchymal liver tract (false channel) between caval and portal systems is created. The goal is to reduce variceal pressure to less than 12 mmHg. Controls bleeding in more than 90% of patients; shunt dysfunction of 50% at 6 months. *Surgical shunts;* two concepts are decompression of high-pressure portal venous system and devascularization of distal esophagus and proximal stomach. Shunts are *non-selective, selective,* or *partial*. Choice is dependent on the underlying state of the liver, the possibility of transplantation in the future, and encephalopathy as a complication of the procedure. **See Sabiston 46, Becker 35.**

Mallory-Weiss Syndrome (MWS)	
Pφ	Tear in the mucosa of the gastric cardia; a linear laceration from forceful emesis/coughing or straining. Results from a rapid gradient increase between intragastric to intrathoracic pressures. In 85% of cases, a single mucosal tear less than 2.5 cm occurs along the lesser curvature. Accounts for 15% of upper GI bleeding.
TP	Upper GI bleeding after forceful emesis with a possible sharp pain initially. Must distinguish from Boerhaave's syndrome, which is full-thickness transmural perforation.
Dx	Endoscopy is the mainstay of dx. A gastrograffin swallow may be needed if a perforation is suspected.
Tx	Bleeding from MWS generally ceases spontaneously in 50% to 80% of patients by the time endoscopy is performed. If bleeding is noted, electrocoagulation and/or sclerotherapy may be used. Consider involving radiology for embolization or intra-arterial vasoactive infusion. Avoid tamponade tubes as they may extend mucosal tears. If the above fails, gastrotomy and oversewing the bleeding lesion should be performed. **See Sabiston 46.**

Gastritis	
Pφ	Mucosal inflammation caused by imbalance of destructive and protective factors. Usually hyperemic edematous mucosa and erosions with various degrees of bleeding. Precipitating factors are stress states such as trauma, head injury (Curling's ulcer), and use of *NSAIDs*.
TP	Patients present with melena and/or anemia. Blood or coffee-ground drainage from NG tube in hospitalized patients.
Dx	Dx is by upper endoscopy. Radiographic studies are not helpful. Important to biopsy for *H. pylori*.
Tx	Remove destructive factors: stop NSAIDs. Tx may include proton pump inhibitors, carafate; treat *H. pylori* as indicated. **See Sabiston 46, Becker 26.**

Gastric Carcinoma	
Pφ	95% of gastric cancers are adenocarcinomas in the United States. Incidence of distal cancers has decreased, while proximal neoplasms have increased. Diet (smoked food, nitrosamines), *H. pylori,* and smoking are risk factors.
TP	Most common presentation is *abdominal pain and weight loss*. Proximal cancers can present with *dysphagia* and distal tumors with *nausea and vomiting* relating to *outlet obstruction*.
Dx	Dx is by endoscopy with biopsy.
Tx	In the absence of disseminated disease, surgery is the mainstay of therapy, with size and location of the tumor determining the extent of gastrectomy and lymphadenectomy, with subsequent reconstruction. Adjuvant therapy is an area of controversy. Recently preoperative chemoradiotherapy followed by resection has shown promise. **See Sabiston 47, Becker 26.**

ZEBRA ZONE

a. Aorto-enteric fistula: Erosion of aortic graft into intestinal lumen; usually third to fourth portion of duodenum. Consider dx in patients with previous abdominal aortic aneurysm (AAA) repair. A "sentinel" GI bleed may herald a massive bleed. CT and upper endoscopy to ligament of Treitz are most useful. **See Sabiston 46.**

b. Hemobilia: Abnormal communication between intrahepatic arterial system and biliary tree, related to neoplastic disease, trauma, vascular malformations, parasitic infection, and coagulopathic states. May present with *RUQ pain, jaundice,* and *GI bleed*. **See Sabiston 52; Becker 17, 18.**

c. Gastrointestinal stromal tumor: 1% of GI neoplasms, arising from the interstitial cell of Cajal and related to mutated *c-kit oncogene*. Gastric location is 65%, with small intestine 25%. Present generally with compressive or displacement symptoms, but one fourth of cases may present with bleed. **See Sabiston 41, Becker 26.**

d. Angiodysplasia: Vascular malformation of abnormally dilated mucosal and submucosal vessels. Cherry spot appearance on endoscopy, often small and superficial. May be congenital (Osler-Weber-Rendu or hereditary hemorrhagic telangiectasia). Acquired lesions are associated with renal failure, aortic stenosis, and cirrhosis. Accounts for approximately 4% of upper GI bleeding. **See Sabiston 46.**

e. Dieulafoy lesion: Vascular malformation of proximal stomach; normally within 6 cm of gastroesophageal junction along the lesser curvature. Large ulcerated submucosal vessel on endoscopy. Usually related to chronic gastritis. **See Sabiston 46.**

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
Unidentified curved bacilli in the stomach of patients with gastritis and peptic ulceration

Authors
Marshall BJ, Warren JR

Reference
Lancet 1984;1(8390):1311–1315

Problem
Was the etiology of ulcer disease acid or some other factor?

Intervention
Endoscopy and documentation of gastric symptoms and pathology in patients. Specimens were examined for bacteria.

Quality of evidence
Prospective nonrandomized trial in 100 patients undergoing EGD

Outcome/effect
The bacteria were present in almost all patients with active chronic gastritis, duodenal ulcer, or gastric ulcer.

Historical significance/comments
Clinicians Marshall and Warren discovered *H. pylori* in the upper GI tract of patients with peptic ulcers and gastritis. The prevailing wisdom at the time was that microorganisms could not live in the stomach and that ulcers were due to increased levels of gastric acid. The tx of gastric pathology has undergone drastic changes based on their work, for which they ultimately received the Nobel Prize in Medicine.

Interpersonal and Communication Skills

When Patients Are Traumatized by Symptoms
Any patient who presents with massive hematemesis will be anxious and traumatized by the condition. It is extremely important to communicate with the patient and family about diagnostic and proposed therapeutic plans. Be mindful that they may be experiencing “emotional flooding” from the stress and fear, which impedes rational and logical thought. Give information in small pieces and allow time to let it sink in.

Professionalism

Commitment to Maintaining Appropriate Relations with Patients
The alcoholic cirrhotic patient will commonly present with variceal hemorrhage. A judgmental attitude on the part of the physician will make the patient encounter extremely unhelpful and hazardous. The patient may well refuse evaluation and life-saving treatments in such situations. Consider a bleeding episode to represent a chance to counsel patients regarding lifestyle risks *after* the initial problem has been addressed.

Systems-Based Practice

Patient Safety: Blood Bank
Hemolytic transfusion reaction is usually due to ABO incompatibility and results in death in 1 in 600,000 transfusions. Providing

appropriate blood products for the patient to prevent such problems involves a complex interaction between the ordering physician, nursing, the blood bank, and the hospital laboratory. A blood sample is obtained from the patient to determine blood type and to cross-match the patient's serum with donated blood to exclude preformed antibodies. The blood product is prepared in the blood bank and carefully labeled for the patient. Before the product is administered, two people are required to confirm the identity of the patient and the designation of the blood product to ensure that the blood is given to the correct patient. The patient is carefully monitored during transfusion to identify any sign of reaction.

Chapter 40
Lower GI Bleeding in a 71-Year-Old Male (Case 25)

Gregg Guilfoyle DO *and Robert B. Noone, Jr.* MD

Differential Diagnosis

Diverticular bleed	Arteriovenous malformation (AVM)	Ischemic colitis
Colon cancer	Hemorrhoids	Upper GI bleed

Speaking Intelligently

When I'm asked to see a patient with blood per rectum, my first step is to stabilize the patient. I assess the *hemodynamic* status, make sure the patient has adequate *IV access* and a *Foley catheter*, and obtain labs, including CBC, PT/PTT, and Chem 7. I send a sample to the blood bank for *cross-match*. I then begin to assess the severity and source of bleeding. I exclude an upper GI source with *NG lavage*. I get the patient to nuclear medicine for a tagged cell scan as soon as possible while the bleeding is active so I can identify the source, and if positive, arrange for a mesenteric angiogram.

PATIENT CARE

Clinical Thinking

- The patient requires close monitoring, usually in the ICU.
- Narrow the differential. R/o an upper source. Place an NG tube.
- Remember resuscitation comes first: correct any coagulopathy and monitor blood count.
- Stabilize as soon as possible and get localization studies while the patient is still bleeding. A physician may need to accompany the patient on transport if the patient is too unstable. Bring the ICU nurse, and don't forget the blood, IV fluid, and fresh frozen plasma (FFP).

History

- Assess the nature of the bleeding:
  - Bright red on the tissue or dripping in toilet bowl after a bowel movement suggests an anal source.
  - Anal pain with blood suggests an *anal fissure*.
  - Blood mixed with stool or bloody diarrhea is usually from a more proximal colonic source.
- Ask about prior episodes. Has the patient had a *colonoscopy*?
- Take a thorough *family hx,* asking about colon cancer.

Physical Examination

- Assess volume status with BP, HR, skin color, capillary refill, conjunctiva color, and mental status.
- Remember that patients will become tachycardic before hypotension ensues.
- Significant blood loss can result in mental status changes.
- A good rectal examination is crucial.
- Anoscopy can r/o an obvious bleeding hemorrhoid.
- The abdomen is typically nontender.

Tests for Consideration

- **CBC:** Most importantly for hemoglobin and hematocrit **$35**
- **PT, PTT:** To r/o coagulopathy **$55**
- **Electrolytes:** Mostly for creatinine to r/o acute renal failure **$45**
- **EGD:** To evaluate an upper GI source **$312**
- **Anoscopy or rigid sigmoidoscopy:** To r/o a rectal source **$175**
- **Colonoscopy:** To evaluate for cancer, AVM, or diverticular source **$800**

IMAGING CONSIDERATIONS

➔**Tagged RBC** scan detects bleeding at 0.1 mL/min and is done first.	$450
➔**Angiography** requires bleeding at 0.5 mL/min and should be done if the tagged RBC scan is positive.	$1,300
➔**Barium enema** should only be considered if bleeding has ceased, since it may interfere with angiography, which may be required.	$350

Clinical Entities — Medical Knowledge

Hemorrhoids

Pφ Hemorrhoids are soft tissue cushions in the anal canal with an arteriovenous plexus. Symptomatic hemorrhoids result from loosening of the supporting connective structure due to chronic straining. Other contributing factors include pregnancy, aging, chronic constipation or diarrhea, and anal intercourse. Enlargement and prolapse of internal hemorrhoids will commonly result in bleeding.

TP Painless blood on the toilet paper or in bowel after defecation, protrusion of tissue out of the anal canal (prolapse).

Dx Anoscopy.

Tx Fiber supplements, rubber band ligation, injectable sclerosants, infrared coagulation, surgical hemorrhoidectomy. Tx depends on stage. **See Sabiston 46, 51; Becker 21.**

Diverticular Bleeding

Pφ Colonic diverticulosis consists of false diverticuli with herniation of mucosa through the colonic muscle wall. This happens at weak points where blood vessels penetrate the muscle wall. Bleeding occurs with disruption of the penetrating vessels into the lumen of the diverticulum. Bleeding can occur in up to 20% of people with diverticulosis and is usually in the right colon. Up to 80% of diverticular bleeds cease spontaneously. 25% of these patients will rebleed in the future.

TP Painless bloody stool, often massive.

Dx Tagged RBC scan and mesenteric angiography during active bleeding to localize the site. Colonoscopy will demonstrate diverticuli but is difficult to use with active bleeding. Barium enema will show distribution of diverticuli in the colon, but gives no information about the source of bleeding.

Tx Bleeding episodes are frequently self-limited. Persistent or recurrent bleeding is treated with colon resection if the location is identified. In severe cases without localization, subtotal colectomy is needed. Subselective arterial embolization is sometimes used if the source is found with arteriography. Occasionally endoscopic therapy with electrocautery or epinephrine injection is used. **See Sabiston 46, 50; Becker 21, 25.**

Arteriovenous Malformation

Pφ AVMs are degenerative lesions due to dilated submucosal veins in the bowel wall. They are usually right sided. 20% of AVMs eventually bleed, and 90% resolve. They do usually recur and therefore require tx.

TP Slow and intermittent rectal bleeding and anemia.

Dx Selective mesenteric angiography can diagnose lesion.

Tx Bleeding is also self-limited. Arterial embolization can be performed by interventional radiology. Colonoscopic coagulation can treat colonic lesions. Surgical resection may be required for repeated episodes. **See Sabiston 46.**

Colon Cancer

Pφ Cancer develops when cells lose control over growth and division. Malignant tumors invade lymphatics and blood vessels and can cause bleeding. Cancers usually progress from precursor polyps.

TP Cancer is present well before symptoms occur. Symptoms include fatigue, weakness, shortness of breath, change in bowel habits, narrow stools, diarrhea or constipation, red or dark blood in stool, weight loss, and abdominal pain. Right-sided cancers usually present with anemia. Left-sided cancers commonly present with obstructive symptoms or blood in the stool.

Dx Barium enema and colonoscopy can diagnose the lesion. Colonoscopy allows for biopsy. If cancer is suspected, metastatic workup is done for staging. CXR, CT, MRI, and bone scan can be performed. CEA may be elevated, especially in metastatic disease.

Tx Benign polyps can be easily removed during colonoscopy and are not life threatening. Malignant tumors require resection, either open or laparoscopic with appropriate lymphatic resection. **See Sabiston 50, Becker 21.**

Ischemic Colitis

Pφ Ischemic colitis is an uncommon cause of GI bleeding, due to inadequate perfusion of the colon. This is commonly nonocclusive ischemia and is divided into *gangrenous* (15%–20%) and *nongangrenous* (80%–85%), and the latter category may be transient reversible ischemia or chronic, nonreversible.

TP Abdominal pain, diarrhea, hematochezia. Pain is usually crampy, frequently in the LLQ. May have associated ileus. Gangrenous ischemia presents with a catastrophic abdominal event with shock and sepsis.

Dx Dx frequently made by hx and physical examination. Colonoscopy is the best study. Mucosal biopsies can be taken, and the degree of ischemia can be classified based on appearance.

Tx Nongangrenous ischemia is usually self-limited and is treated with bowel rest and antibiotics. Full-thickness ischemia requires resection (see also Case 8). **See Sabiston 50, Becker 21.**

ZEBRA ZONE

Inflammatory bowel diseases also can cause bleeding. Patients with Crohn’s disease and ulcerative colitis (UC) have a hx of intermittent diarrhea and constipation. UC can cause bleeding. Family hx is helpful. Resection is reserved for complications of Crohn’s disease and may be curative in UC. **See Sabiston 48, 50; Becker 22.**

Practice-Based Learning and Improvement: Morbidity and Mortality Self-Assessment Form	
Complication	Acute hemolysis due to a transfusion reaction
Type	Human error, system failure; preventable
Surgery performed	None
Patient's disease	72-year-old man presented with an acute lower GI bleed.
Presentation	Sudden onset of back pain, fever, chills, tachycardia, hemoglobinuria
Intervention	Stopping the transfusion, IV fluids to re-expand the blood volume, pressors, back-checking the blood
Outcome	The transfusion was stopped and the patient was supported with volume and pressors. After requiring intubation and dialysis, the patient required pressor therapy and succumbed.
Risk factors	Requirements for multiple transfusions and human error in checking the blood
How were risks addressed?	The blood was checked with the patient ID by two people.
What happened?	There were two patients with the same name in the hospital requiring transfusions with different ABO blood types, resulting in an antibody-mediated major transfusion reaction.
What could have been done differently?	Both the name and medical number of the patient need to be compared to the blood products to ensure the administration of the correct blood products.
Would outcome have been different?	The patient might have survived.

Interpersonal and Communication Skills

Cultural Awareness
As the country grows more ethnically diverse, physicians need to remain mindful of cultural differences.

Barriers posed by language and ethnic traditions can result in negative health consequences, including:

- Failure to recognize and respond to health problems
- Inadequate informed consent
- Misinterpretation of physician's instructions
- Poor compliance with tx plans
- Missed appointments
- Inaccuracies in medical histories

Long-term studies indicate that language barriers alone are responsible for:

- Fewer clinical visits
- Lengthier clinical visits
- More laboratory tests
- More ED visits
- Limited follow-up
- Dissatisfaction with health-care services

Professionalism

Commitment to Maintaining Trust by Managing Conflicts of Interest
A conflict of interest is a set of conditions in which professional judgment concerning a primary interest (such as patient welfare or the validity of research) tends to be unduly influenced by a second interest.[1] As in all other medical/surgical arenas, decisions for endoscopic versus surgical tx of bleeding should always be evidence-based decisions centered on what's best for the patient, not based on who may gain financially by performance of a procedure.

Systems-Based Practice

IT in Training: Use of Simulators and Assessment of Technical Competence
A patient with a third episode of lower GI bleeding is admitted and an angiographer identifies and embolizes a bleeding diverticulum in the sigmoid colon. The bleeding ceases and you recommend a laparoscopic colectomy, a procedure that wasn't widely practiced or taught during your training.

As a board-certified physician, you will be increasingly required to prove your competence to diagnose, treat, and manage diseases related to your discipline. Once you complete residency, it may be difficult to add new techniques to your armamentarium without subjecting patients to the dangers of your inexperience. Fortunately, to learn and assess clinical competence, there are safer learning opportunities available, including the use of simulators. Keep abreast of new developments, anticipate your learning needs, and participate in continuing education to update your skills and the quality of your patient care.

Reference

1. Thompson DF: Understanding financial conflict of interest. N Engl J Med 1993;329:573–576.

Chapter 41
Anorectal Pain in a 45-Year-Old Male (Case 26)

Catherine M. Schermer MD and W. Randall Russell MD

Differential Diagnosis

Hemorrhoids	Fissure	Abscess
Prolapse	Fistula	Squamous cell carcinoma

Speaking Intelligently

When a 45-year-old male presents with a hx of anorectal pain, I start with a hx, including details about the onset and quality of the pain, the presence of a mass, discharge, bleeding, and change in bowel habits. A focused physical examination of the abdomen and rectum is necessary. I try to be sure I have set the patient at ease before proceeding to examination. Performing a rectal examination includes proper positioning of the patient, inspection of the anal area, palpation with a lubricated and gloved index finger, anoscopy, or proctosigmoidoscopy. It is important to inform and reassure the patient during your examination. Dx is usually made by hx and physical examination; ordering a battery of tests is usually unnecessary when anorectal pain is the chief complaint.

PATIENT CARE

Clinical Thinking

- After obtaining a good hx, think about the presenting symptoms you would expect to find in each differential dx; then confirm your dx with visual inspection and rectal examination.

History

- Consider the nature, duration, location, and type of pain. Is pain associated with defecation? Is bright red blood present on tissue paper or in the toilet bowl?
- ***A thrombosed hemorrhoid*** presents with acute onset of continuous anal pain, unrelated to defecation and often associated with a small, discolored, hard lump the size of a pea.
- Suspect an ***anal fissure*** if pain is experienced during defecation and also associated with some degree of bleeding.
- A firm tender swelling in the perianal area, worsening over a few days, suggests a ***perirectal abscess***.
- ***Anal fistula***, often seen with a previous hx of an anorectal abscess, causes pain/discomfort and a persistent discharge.
- Protrusion of a "reddish-like" mass following defecation and complaints of incontinence raise the suspicion for ***rectal prolapse***.
- ***Squamous cell carcinoma*** of the anus is uncommon, but if a patient presents with an anal mass, biopsy is essential.

Physical Examination

- Four basic approaches to a good rectal examination include:
  1. Proper positioning in either the prone-jackknife position, the knee-chest position, or the left lateral decubitus position. The least embarrassing and most patient-accepted position is the left lateral.
  2. Inspect the anal area for ***hemorrhoids,*** a ***fistula,*** or ***prolapse***. Pain on inspection is often associated with a ***thrombosed hemorrhoid***, ***fissure,*** or ***abscess***. Evaluation of the perianal skin and anal opening, while having the patient perform a valsalva maneuver, may provide further valuable information.
  3. Palpation with a water-soluble lubricant applied to a gloved index finger aids in examination of the rectum and its surrounding structures, including assessment of sphincter tone and contractility. Testing for occult fecal blood is appropriate when stool is present on the examining index finger.
  4. Anoscopy or proctosigmoidoscopy (if available during examination) offers the best means to evaluate ***hemorrhoids*** and other lesions of the anal canal not palpated on digital examination. If a patient has a ***fissure***, digital exam and use of instruments should often be avoided since it will cause excessive pain and discomfort.

Tests for Consideration

- **CBC:** Leukocytosis is suggestive of infection/inflammatory process. $35
- **Proctosigmoidoscopy/anoscopy:** Reveals mucosal/polypoid lesions, cancer, inflammatory changes, stricture, vascular malformation, and anal conditions. $135

IMAGING CONSIDERATIONS

➔**Endorectal ultrasonography:** Helpful in further visualizing and diagnosing anorectal conditions not easily seen by inspection or felt on palpation $225

➔**CT** may be helpful in diagnosing the extent and location of an abscess. $950

Clinical Entities — Medical Knowledge

Hemorrhoids

Pφ ***Hemorrhoids*** can be either internal or external. When the cushions of the subcutaneous tissues of the anal canal become dilated (seen above the pectinate line) internal hemorrhoids develop. Abnormal dilatation of the veins surrounding the anus (seen below the pectinate line) is consistent with external hemorrhoids.

TP Internal hemorrhoids are usually painless and associated with bleeding. Externals are associated with pain and itching and may cause difficulty with anal hygiene.

Dx Dx of internal hemorrhoids is made by anoscopy or proctoscopy. External hemorrhoids are often visualized on inspection.

Tx Tx is initially medical, using sitz baths, stool softeners, and dietary modifications. Thrombosed external hemorrhoids causing severe pain can be treated operatively with evacuation of clot and excision of the hemorrhoid. Internal hemorrhoids can be treated with band ligation, which causes necrosis and eventual sloughing. External hemorrhoids can also be removed by performing a surgical hemorrhoidectomy. **See Sabiston 46, 51; Becker 21.**

Fissure

Pφ A ***fissure*** is a tear in the anal mucosa. An acute fissure usually heals with conservative therapy. A chronic fissure has the internal anal sphincter exposed in the base of the tear, and results in spasm of the smooth muscle that inhibits healing of the fissure because of decreased perfusion—an ischemic ulcer.

TP Pain during or immediately after a bowel movement. Patients often describe a “knife-like pain” and defecating is like “passing broken glass.” Bright red blood often on toilet paper. Patients with chronic fissures often have pain from the spasm, which can last for hours.

Dx The most common location is in the posterior midline. The dx is made by careful effacement of the anus between two fingers to expose the ulcer. Patients are frequently too uncomfortable to undergo rectal examination.

Tx Fissures are often managed nonoperatively with warm sitz baths, dietary bulking agents, and topical smooth muscle dilators like nitroglycerin or nifedipine ointment. Fissures should heal within 6 weeks. Operative management is reserved for chronic fissures. Lateral internal sphincterotomy is the procedure of choice, often relieving chronic sphincter spasm. **See Sabiston 51, Becker 21.**

Abscess

Pφ ***Abscess*** formation is believed to be the result of plugging of the anal ducts located around the anal canal, causing localized infection. Spread of infection can occur to the *intersphincteric* space as well as the *perianal, ischiorectal,* and *supralevator* spaces, causing a variety of presenting symptoms.

TP Patients present with a tender, erythematous, often fluctuant mass in the anorectal area. Fever and chills can be present along with a leukocytosis. Patients with diabetes and immunodeficiency require immediate tx with antibiotics and surgical intervention.

Dx Dx is usually made on anorectal examination. CT of the pelvis can be used to demonstrate supralevator extent of the abscess. Sometimes examination under anesthesia is needed to find intrasphincteric and supralevator abscesses that do not have external signs.

Tx Tx depends on the location, size, and extent of the abscess. Incision and drainage with washout can often be performed at the bedside with daily local wound care. Patients with large abscesses, diabetes, and immunodeficiency syndromes are usually drained in the operating room. **See Sabiston 51, Becker 21.**

Fistula

Pφ ***Fistula*** formation is usually seen in patients with a hx of an anorectal abscess or inflammatory process. A fistula is a tract, a communication between the anal crypts and perianal skin, which develops in approximately 50% of patients after drainage of an abscess. Fistulae are classified by the course of the tract: *intrasphincteric, transsphincteric, extrasphincteric,* and *supralevator.*

TP Patients often complain of swelling, pain, and discharge of mucus or foul-smelling fluid mixed with stool.

Dx Dx is made by inspection and rectal examination. Use of anoscopy can help to locate the internal opening. Usually examination under anesthesia is required to identify the course of the tract and to treat.

Tx Management consists of first identifying the fistula tract then performing a fistulotomy, which allows the tract to drain, heal, and eventually close. The tract can also be unroofed and drained if persistent abscess formation is present. **See Sabiston 51, Becker 21.**

Prolapse

Pφ ***Prolapse*** occurs as a result of weakness in the levator muscle anteriorly and various ligamentous structures laterally that aid in holding the rectum in place. Increased straining with defecation causes a downward vertical position of the rectum, which, when combined with muscular weakness, results in either a full-thickness prolapse seen with concentric mucosal folds or a partial-thickness prolapse characterized by radial mucosal folds.

TP Patients present with pain, constipation, fecal incontinence, and gross prolapse.

Dx Dx can be made by rectal examination. Having the patient strain on a commode will usually demonstrate the prolapse.

Tx Nonoperative treatments include manual anal support while defecating, correction of constipation, perineal strengthening exercises, and injection of sclerosing agents. Surgical therapy includes obliteration of the pouch of Douglas, restoration of the pelvic floor, resection of bowel via a perineal versus a peritoneal approach, and suspension or fixation of the rectum. **See Sabiston 51, Becker 21.**

Squamous Cell Carcinoma

Pφ ***Squamous cell carcinoma*** is usually associated with infection with human papillomavirus (HPV) oncogenic subtypes 16 and 18 and in many cases can be thought of as a sexually transmitted disease, clinically related to the development of anal warts. Cancer development is by integration of HPV DNA into anal canal cell chromosomes.

TP Patients typically present with a mass associated with bleeding and pain. It is often first misdiagnosed as a hemorrhoid.

Dx Anorectal biopsy is the procedure of choice for making the dx. Biopsies of nearby enlarged lymph nodes assess regional extension.

Tx The combination of radiation and chemotherapy has helped to improve survival without radical surgery. If residual tumor is present following chemoradiation, an abdominal perineal resection is performed (*see discussion, Professor's Pearls, scenario #3*). **See Sabiston 51, Becker 21.**

ZEBRA ZONE

a. **Impaction:** Fecal impaction consists of a large mass of dry, hard stool that develops in the rectum due to chronic constipation. The stool can be so hard that a patient is unable to defecate. Watery stool from higher in the bowel may move around the mass and leak out, causing incontinence. **See Sabiston 51.**

b. **Inflammatory bowel disease:** In the presence of anorectal pathology, it is important to r/o inflammatory bowel disease, particularly before performing an invasive procedure such as a hemorrhoidectomy (*see M & M form on the following page*). **See Sabiston 48, 50, 51; Becker 22.**

c. **Sexually transmitted disease:** *Condylomata acuminata* (anal warts) is one of the most common and troublesome sexually transmitted conditions because it is difficult to eliminate surgically. Patients often present with small, discrete, vegetative excrescences in the anal region that appear as closely grouped papillomas, creating an almost cauliflower-like appearance. *Herpes simplex, syphilis*, and *chancroid* cause painful atypical anal ulcers. Anorectal *gonorrhea* causes pain, itching, and bloody or mucoid discharge. **See Sabiston 51.**

d. **Tuberculosis,** more commonly seen in developing countries, may present as an anal fissure in an unusual location (not midline) that is slow to heal. These lesions may be confused with Crohn's disease, fissure, or fistula. Dx is made based on the demonstration of acid-fast bacilli in the biopsy specimen and the presence of caseating granulomas in histologic examinations.

Practice-Based Learning and Improvement: Morbidity and Mortality Self-Assessment Form	
Complication	Chronic ulceration following hemorrhoidectomy
Type	Unnecessary procedure, error in judgment, error in dx; preventable
Surgery performed	Hemorrhoidectomy
Patient's disease	Skin tags in the perineum during active Crohn's disease
Presentation	31-year-old woman with tender skin tags and fissures and diarrhea
Intervention	Hemorrhoidectomy
Outcome	Chronic ulceration of the excision site with worsening pain
Risk factors	Crohn's disease, unrecognized symptoms of Crohn's disease including multiple off-midline fissures
How were risks addressed?	Sitz baths, local wound care, and control of diarrhea
What happened?	The patient continued to have pain and drainage from the operative site for 2 months postoperatively due to the poor wound healing associated with Crohn's disease.
What could have been done differently?	Local wound care and medical tx of Crohn's disease in lieu of surgical tx, as well as recognizing classical symptoms of Crohn's disease.
Would outcome have been different?	Healing of the fissures as well as tx of the underlying disease.

Interpersonal and Communication Skills

Overcoming Awkwardness in Obtaining an Accurate Patient History

Patients with anorectal complaints are often embarrassed to discuss their real concerns. In the instance of a mass, the patient frequently has an underlying concern regarding the possibility of cancer. The presence of a lesion or the suspicion of trauma often raises the issues of anal intercourse and disease transmission, which will often remain unspoken.

Students, residents, and physicians often feel uncomfortable asking what are very appropriate questions in these matters. It is important to assure confidentiality, remain nonjudgmental, and explain that your utmost concern is the patient's health and privacy. Indeed, some situations can be difficult to address: all the more reason one needs practice to develop a therapeutically appropriate comfort level in discussing the "unmentionable" topics. Feeling uncomfortable is not a reason to avoid getting an accurate patient hx.

Professionalism

Commitment to Maintaining Appropriate Relations with Patients

The rectal examination is a challenging aspect of the physical examination, particularly when pathology is present. The examination can cause embarrassment and discomfort for the patient. It is essential to gain the patient's trust by providing a safe and private environment and by explaining to the patient what is about to be done and what he or she may experience. Although it is important for students to learn the proper way to perform a rectal examination (and particularly to be able to see and palpate pathological findings), one should minimize the number of examiners. And always remember to have an observer present during any part of the rectal examination.

Systems-Based Practice

Reimbursement: Copayments and Deductibles

You have just examined a woman who has an anal fissure and you escort her to the reception desk to set up a follow-up appointment. Your secretary asks her for her copayment.

The primary purpose for charging copayments is to deter people from seeking care that they do not need. Health economists have studied this issue, known as *elasticity of demand*, and have determined that when health care is entirely free, people seek unnecessary care. However, when a small portion of the cost is assigned in the form of a copayment, they tend to seek only the care they need. If the amount of the copayment is too high, people will not seek care. Insurers strive to set copayments at an amount that discourages waste of health-care dollars while maintaining accessibility so that people seek the care they need.

If you have had the opportunity to evaluate a patient with GI bleeding, you are encouraged to review your patient's course in the context of the Competency Self-Assessment Form on page 35, which can also be found as a Word document on the book's Web site at www.studentconsult.com. In your review pay particular attention to how the quality of collaboration among the various hospital services (e.g., Gastroenterology, Surgery, the ED, and the OR) may have affected the care of your patient.

Professor's Pearls: GI Bleeding

Section Review

Consider the following clinical problems and questions posed. Then refer to the professor's discussion on these issues.

1) A 59-year-old male presents with hematemesis. He has a hx of arthritis for which he is taking NSAIDs regularly. He gives a hx of a 12-pound weight loss and vague postprandial abdominal pain for 3 weeks. On examination there is alcohol on his breath. His temperature is 98.8, his pulse is 120, and BP is 90/60.
What are your first steps? What is the differential dx?

2) A 71-year-old woman presents with severe lower GI bleeding. She has no previous bleeding hx. She gives a hx of hypertension and atrial fibrillation and she has been on Coumadin for 2 years. Her VS on presentation are T = 98.6, P = 115, BP = 105/60.
What are your first steps? What is your differential dx? What do you do if the bleeding is brisk and persistent and you cannot localize it?

3) A 60-year-old male comes to your office with a complaint of hemorrhoids. He has had several episodes of bleeding on toilet paper in the past several months. Digital rectal examination reveals a mass near the anal verge.
What would you do if a biopsy revealed squamous cell carcinoma?
What would you do if the mass was adenocarcinoma?

Discussion by John H. Marks, MD, Chief, Colorectal Surgery, Main Line Health System, Wynnewood, Pennsylvania

Answer 1
This 59-year-old male with an upper GI bleed on NSAIDs has alcohol on his breath and a significant weight loss. He presents in class II shock with both tachycardia and hypotension. My approach begins with the ABCs. Two large-bore IVs would be placed (18 gauge or larger), and 2 L of lactated Ringer's would be infused. If he continues to be hypotensive, I would transfuse blood. Labs should include CBC, PT, PTT, platelets, SMA7, LFTs, amylase, lipase, and a cross-match for 4 units of blood. The blood bank should be informed to have 2 units of blood ready at all times. A Foley catheter should be placed.

With a hx of NSAIDs, my differential dx is headed by the possibility of an ulcer. Alcohol on the breath brings to mind the possibility of esophageal varices, and I would look for stigmata of portal hypertension on physical examination. A 12-pound weight loss also raises the possibility of an esophageal or gastric carcinoma. Cancer, however, is more likely to present with chronic anemia than an active GI bleed.

My key diagnostic maneuver is upper GI endoscopy. Depending on the volume of bleeding, I would consider intubating the patient in order to protect his airway during this maneuver.

If the patient proves to have a posterior duodenal ulcer, which could not be controlled by endoscopic means, he would be taken to the OR where an anterior duodenotomy would be carried out so that the ulcer could be oversewn. Definitive therapy with a vagotomy and pyloroplasty (or highly selective vagotomy) would be considered if the peptic ulcer disease was felt to be chronic.

Answer 2

This 71-year-old woman on anticoagulation presents with a severe lower GI bleed. The first steps for someone in class I shock are the ABCs. Her airway should not be a problem. A large-bore 18-gauge IV should be placed. (My initial approach is similar to my approach for patient #1.)

Has this woman ever had an episode like this before? Have her coagulation studies been stable? I ask myself, what might have altered them? Any change in Coumadin dosage? New medications or antibiotics? Has she had any problems with diarrhea or abdominal pain? Has she been sick or not eating well? (Any change in nutritional status can have a profound effect on the stability of a patient's anticoagulation.)

Tx begins with fluid resuscitation. The differential dx includes both upper GI sources and lower GI sources. Hence, an NG tube should be placed to lavage the stomach. The absence of blood does not constitute a negative test for an upper GI bleed unless there is bilious content in the NG tube return.

The differential dx for a lower GI bleed includes disease in the small intestine, colon, and anorectum. The most common colonic sources would be ***arterial venous malformations*** (AVMs) and ***diverticular disease.*** Other possibilities in a patient who is anticoagulated include ***neoplasia, ischemic colitis*** with paradoxical bleeding, ***trauma,*** and ***inflammatory bowel disease.*** The most common causes of a small bowel bleed would be an ***AVM*** or a ***leiomyoma.*** Anorectal sources must always be considered: ***hemorrhoidal*** bleeding can be quite brisk, especially in the anticoagulated patient. There is nothing more embarrassing than having a bleeding hemorrhoid diagnosed by an angiogram! To that end, physical examination must include a digital rectal examination. Anoscopy and/or rigid sigmoidoscopy should be carried out to examine for anorectal sources. Blood at the anal verge and the absence of blood in the sigmoid colon points to an anorectal problem. However, blood in the sigmoid colon doesn't necessarily r/o the anorectal source, as back-filling of the sigmoid from high-volume hemorrhoidal bleeding with the sphincters clamped shut can give this picture.

Assuming the lavage of the stomach is negative, my first test would be a nuclear bleeding scan. If it is my impression from the blood passed below that the patient is bleeding briskly, I would go directly to arteriography. The benefit of arteriography is that it gives a much more precise localization of the source of the bleeding and assists greatly should you need to go to the OR. Many radiology departments have adopted the attitude that they won't perform arteriography without first doing a nuclear medicine bleeding scan in order to minimize the number of negative invasive studies. Patients must be bleeding actively for either a bleeding scan or arteriography to demonstrate a lesion; for a nuclear bleeding scan to test positive, the patient has to be bleeding between 0.1 and 0.5 mL per minute and for arteriography to be positive more than 1 mL per minute.

Another school of thought is to go directly to lower GI endoscopy in these patients, the benefit being that endoscopy can be therapeutic as well as diagnostic. In my experience, however, it is very difficult to obtain a good look at the mucosa endoscopically when there is a large volume of blood in the bowel lumen. And bowel prep is not well tolerated in these hypovolemic patients. I should also state that we are not proponents of angiographic embolization of bleeders in the colon as definitive therapy. An intentional embolus in this area should be considered a temporizing measure on your way to the OR. The end organ aspect of the vasculature of the colon puts the patient at a very high risk for transmural infarction and perforation 3 to 7 days after embolization.

If the patient has not stopped bleeding and has received more than 6 units of blood within a 24-hour period, the next step is surgery. This should have been preceded by more than one trip to nuclear medicine or arteriography in an attempt to localize the source of bleeding. When localization is unsuccessful and I do take the patient to the OR, my first approach is to explore and see where the blood has pooled. Assuming there is not a large volume of blood in the small bowel (indicating the bleeding is above the colon), I would likely proceed with a subtotal colectomy. Depending on the patient's hemodynamic stability, I would perform an ileorectal anastomosis or an end ileostomy. If there is any question whatsoever regarding the patient's nutritional status or hemodynamic stability, an anastomosis should be avoided.

Answer 3

A thorough examination of the patient is essential, including details of the location of the lesion—anterior, posterior, to the right or the left, whether it is above or below the levators and, if so, by how many centimeters? The differentiation between a rectal cancer and anal cancer in the examiner's mind is of paramount importance. Also important is the size of the lesion and whether it is fixed to the sphincters. In order to make proper decisions regarding tx, important hx points are fecal continence, bowel hx, and the presence/absence of pain.

What if the biopsy shows a ***squamous cell carcinoma*** at the anal verge? Squamous cell carcinoma of the anus has seen a real revolution in therapy over the last 30 years. This is a radiosensitive lesion and primary definitive therapy is that of chemoradiation. First, prove the dx by biopsy. Careful evaluation of the inguinal lymph nodes should be carried out as well as proximal evaluation of the colon by colonoscopy. CT of the chest, abdomen, and pelvis should be performed. Assuming no other abnormalities are found, the approach would be chemoradiation, generally with 5-fluorouracil and mitomycin at the beginning and at the end of radiation therapy, with tx dosage between 4,500 and 5,500 cGy. Reevaluation of the mass at 3-week intervals is carried out and if there is a residual scar 4 to 6 weeks following the completion of therapy, this area is re-biopsied. (If there is no residual scar and no induration or ulceration [i.e., a complete response], this area is observed serially.) If biopsy is carried out and it proves to be positive (this only happens in approximately 20% of the cases), then an additional boost of 3,000 cGy is given. If the patient persists with anal cancer after that point, an abdominal perineal resection should be carried out. ***Students should note that this is a tremendous change from tx in the 1970s, when all such patients with squamous cell carcinoma were treated with abdominal perineal resection (APR).***

What if the biopsy shows ***adenocarcinoma*** 3 cm from the dentate line? That being the case, this would be a ***rectal cancer*** and not an ***anal cancer.*** Evaluation would be carried out clinically, as well as with endorectal ultrasonography or a 3-Tesla coil MRI to evaluate the tumor thickness in the rectal wall. In the distal 3 cm of the rectum there would always be a very high risk for a local recurrence. Accordingly, we advocate, even for T1 or T2 cancers, that these patients undergo ***preoperative chemoradiation.*** If following the completion of radiation the lesion appears mobile, we advocate sphincter-preserving surgery. Everyone is in agreement that a T3 cancer or a node-positive cancer on staging would undergo preoperative radiotherapy. There are some surgeons who would advocate local excision and some who advocate abdominal perineal resection for lesions at this level. It is our approach to treat the patients with 5,500 cGy and, if the lesion is mobile, we perform a transanal transabdominal proctosigmoidectomy with descending coloanal anastomosis. The advantage of this approach is to start the operation at the dentate line (***from below, not in the abdomen***) in order to have a known distal margin so that sphincter preservation can be carried out.

If a question exists regarding your ability to do such an anastomosis, and if referral to a specialty center is not available, an APR should be carried out.

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Chapter 42
Chest Pain (Case 27)

Peter F. Lalor MD

Postoperative context: A 67-year-old man develops chest pain on postoperative day 2 after a sigmoid colectomy for diverticulitis.

Differential Diagnosis

Myocardial infarction	Pneumonia	Gastroesophageal reflux
Pulmonary embolus	Pneumothorax	Anxiety

Speaking Intelligently

When called to see a postoperative patient complaining of chest pain, I think about those issues that could get the patient into trouble quickly. After an appropriate hx and a physical examination concentrating on vital signs, O_2 saturation, and physical examination of the chest, if acute myocardial infarction (MI) remains in the differential, I obtain an EKG, send off cardiac enzymes, give O_2, and consider MONA (*morphine, O_2, nitroglycerin, analgesia*; see below). A CXR is usually appropriate, and if there is a suspicion of pulmonary embolism, I consider a spiral CT. With attention to life-threatening issues first, other diagnoses will become clear. While showing my concern for the situation, I try to be reassuring to the patient and I include the patient's nurses in the discussion of the workup and any interventions.

PATIENT CARE

Clinical Thinking

- First r/o the immediate life-threatening cardiopulmonary complications. *MI* can occur anytime, yet frequently presents on POD #2 or #3 after major surgery. Suspicion for *pulmonary embolus (PE)* should be high in any surgery patient, especially those with multiple risk factors for deep venous thrombosis (DVT).
- A quick review of the chart and a focused hx and physical examination should narrow the differential. Ask specifically about new versus old symptoms.

History

- Characterize the pain by site, radiation, and nature. The timing of the pain is also important from onset, duration, and prior episodes of similar symptoms.
- ***MI*** is often described as a "heaviness" or "crushing" chest pain that may radiate to the jaw or left arm. ***PE*** will often present with shortness of breath as well. These patients may or may not have a hx of DVT. Chest pain is not common in ***pneumonia***, but a hx of prior lung disease or aspiration during anesthesia predisposes to pulmonary infection. Spontaneous ***pneumothorax*** is unlikely, but consider recent thoracic procedures, including central line insertion. A thorough hx of prior symptoms will elucidate the likelihood of chest pain from ***gastroesophageal reflux*** or ***anxiety***.

Physical Examination

- Stop and look. Inspection from the end of the bed can often hint to the severity of the acute process and whether or not ICU transfer is necessary. A pale, diaphoretic, and tachypneic patient may point towards ***MI*** and the ICU.
- **VS:** Tachycardia may accompany all possible entities. Fever and tachycardia are suspicious for ***PE***, although physical examination findings in ***PE*** are often unremarkable. Hypotension may represent massive ***PE*** or ***MI***. Oxygen desaturation more likely indicates ***PE, pneumonia***, or ***pneumothorax***.
- Auscultation of the heart may reveal new murmurs suggesting an ***MI***. Rhonchi on auscultation of the lungs may confirm consolidation in ***pneumonia,*** and absence of breath sounds suggests ***pneumothorax***.

Tests for Consideration

- **WBCs:** Elevated in infection and *pneumonia* **$35**
- **Hb:** Anemia contributes to cardiac stress **$32**
- **Electrolytes:** Important to correct in cardiac etiology **$35**
- Serial cardiac enzymes (CK, CK-MB, troponin): To r/o cardiac muscle damage **$115**
- **ABG:** *PE* gives respiratory alkalosis **$65**
- **EKG:** Will diagnose most *MI*s (compare EKG to prior study) **$125**

IMAGING CONSIDERATIONS

→**CXR:** Portable AP CXRs are notoriously poor quality. Erect **CXR** in full expiration is best but requires transport to x-ray. Evaluate for pneumothorax, congestive heart failure, PE, atelectasis, pneumonia, pleural effusions, and hemothorax. **$120**

→**Spiral CT with PE protocol:** When performed technically well, spiral CT is the fastest, most effective means of evaluating for *PE*. Can also r/o aortic dissection and pneumothorax. Requires IV iodinated contrast, so monitor renal function. **$1,200**

→**V/Q scan:** Perfusion/ventilation nuclear scan is useful in cases of renal insufficiency or iodinated contrast allergy as an alternative to CT. May require several hours of turnaround time to complete the study depending on availability of isotopes. When patient is mechanically ventilated, only perfusion scan can be done. **$600**

→**Echocardiography:** Will demonstrate cardiac dysfunction from *MI* or right ventricular strain pattern in massive PE. **$325**

Clinical Entities — Medical Knowledge

Myocardial Infarction

Pφ *MI* occurs with ischemic insult to the myocardium, often in patients with known coronary artery disease or known risk factors for atherosclerosis. Although an MI can occur at any time, it commonly occurs on POD #2 or #3. Any episode of intraoperative hypotension can also cause cardiac muscle damage.

TP Typical symptoms and signs include chest pain radiating to the jaw or left arm with diaphoresis, pallor, dyspnea, or tachycardia. EKG changes are usually present. The first set of cardiac enzymes may be normal.

Dx MI may be difficult to diagnose by hx and physical examination alone, particularly in intubated patients and those with thoracic surgery or distracting surgical pain.

Tx Immediate tx is MONA (morphine, O_2, nitroglycerin, analgesia). Observation requires at least telemetry monitoring, a cardiology consultation, and possible ICU monitoring. **See Sabiston 15, 61; Becker 29.**

Pulmonary Embolism

Pφ ***PE*** occurs when a blood clot lodges in the lumen of a pulmonary artery, causing significant respiratory and sometimes hemodynamic dysfunction. Pulmonary emboli may originate from any DVT, but usually originate from the deep leg veins and travel to the pulmonary arterial system.

TP Signs and symptoms include acute dyspnea and chest pain (varying with respiration) associated with tachycardia, tachypnea, and sometimes fever. Hypotension indicates a large PE and is life threatening. Oxygen requirement is usually but not always increased, and ABG will often show respiratory alkalosis.

Dx Definitive dx is made by CT angiography of the chest with PE protocol. V/Q scan is less sensitive and is interpreted by the probability of PE based on ventilation and perfusion mismatch in the lungs.

Tx Anticoagulation with heparin is the preferred tx. Inferior vena cava (IVC) filters are used in cases of PE where anticoagulation cannot be used. Massive PE with hypotension prompts consideration of catheter-guided embolectomy (interventional radiology) versus surgical embolectomy, as thrombolytics are generally contraindicated in the immediate postoperative period. **See Sabiston 15, 59; Becker 36.**

Pneumonia

See Chapter 43, Shortness of Breath (Case 28)

Pneumonia may present with chest pain as well as shortness of breath. Pneumonia is covered in greater detail in Chapter 43, Shortness of Breath (Case 28). **See Sabiston 15, 59; Becker 5, 10.**

Pneumothorax

Pφ ***Pneumothorax*** is an abnormal accumulation of air between the pleural lining of the lung and the chest wall, causing lung compression and collapse. Spontaneous pneumothorax occurs when a bleb ruptures. Tension pneumothorax is often related to iatrogenic injury from central line insertion, barotrauma from ventilation, or surgical trauma. If the pneumothorax is not decompressed, air will continue to fill the pleural space until total lung collapse and major vessel compression occurs from the increased pressure.

TP Patients have chest pain, dyspnea, and oxygen desaturation.

Dx Dx can be made clinically with auscultation and physical examination or by CXR (best as erect full expiratory film).

Tx Urgent tx necessitates needle decompression followed by tube thoracostomy (chest tube). If the lung is less than 10% to 15% collapsed, serial CXRs may suffice while the lung reexpands over a few days. **See Sabiston 15, 57; Becker 28.**

Gastroesophageal Reflux

Pφ ***Gastroesophageal reflux*** is the reflux of gastric contents into the esophagus secondary to an incompetent or relaxed lower esophageal sphincter. This phenomenon happens with increased frequency in postoperative general surgery patients who have NG tubes in place.

TP Patients have a "burning" substernal chest pain; many patients will have a previous hx of gastroesophageal reflux.

Dx Dx in a postsurgical patient is a made by hx and ***exclusion of other cardiopulmonary processes***.

Tx Tx involves histamine (H2) blockers or proton pump inhibitors. **See Sabiston 15, 42; Becker 27.**

Anxiety

Pφ ***Anxiety*** is a complex combination of fear, apprehension, and worry that can present with physical manifestations.

TP Symptoms and signs of chest pain, dyspnea, tachycardia, and palpitations can simulate other cardiopulmonary events.

Dx It is important to recognize that though most patients will have an element of anxiety in the postoperative period, ***cardiopulmonary causes must be excluded before one can settle for "anxiety" as a correct dx in this setting***. A common experience for the novice house officer is to receive a call about a patient's "anxiety" and respond by prescribing an analgesic or anxiolytic prior to determining whether there is an underlying physiological problem, particularly hypoxia. ***When receiving such a call, be sure to examine the patient and check the O_2 saturation or ABG when appropriate.***

ZEBRA ZONE

a. **Musculoskeletal pain:** Bone and muscle pain is due to localized inflammation, contusion from trauma, and possible positioning on the OR table; in the postoperative situation it is a dx of exclusion. **See Sabiston 21.**

b. **Aortic dissection:** Unlikely as a postoperative complication, aortic dissection is a rare intramural tearing of the aorta. The chest pain is searing in nature without EKG findings. CXR will show widened mediastinum. CT angiography is the definitive diagnostic study. **See Sabiston 63, Becker 29.**

Practice-Based Learning and Improvement: Evidence-Based Medicine

Title
Multifactorial index of cardiac risk in noncardiac surgical procedures

Authors
Goldman L, Caldera DL, Nussbaum SR, et al.

Institution
Multi-institutional study

Reference
New England Journal of Medicine 1977;297(16):845–850.

Problem
Evaluate the cardiac risk for patients undergoing noncardiac surgery who have had a recent MI.

Intervention
None, multivariate analysis led to identification of risk factors.

Quality of evidence
Prospective, nonrandomized multivariate analysis of 1,001 patients

Outcome
Risk of cardiac death in a patient with no hx of MI is approximately 1%. If the patient had an MI more than 6 months prior to surgery, the risk is 6%. If the patient had an MI fewer than 3 months prior to surgery, the risk is between 16% and 37%.

Historical
There were nine preoperative predictors: JVD; MI in the preceding 6 months; more than five premature ventricular contractions (PVCs) per minute; rhythm other than sinus or presence of premature atrial contractions (PACs) on preoperative EKG; age over 70 years; intraperitoneal, intrathoracic, or aortic operation; emergency operation; significant aortic stenosis; and poor general medical condition.

Significance/comments
This important paper identified four classes for postoperative cardiac events. The focus of the cardiac risk index is the hx of a previous MI. This article identified the time period of highest cardiac risk for surgery for patients with a previous MI.

Interpersonal and Communication Skills

Speaking in the Acute Situation
As in the case of a 67-year-old patient who has new onset of acute chest pain, unexpected complications can be frightening for both patients and their families. In speaking with the patient and family, take time to explain the possibilities and their ramifications in simple language. Use a normal rate of speaking and stop often to check for understanding. A typical rate of speech between medical professionals is too fast for patient communication. A fast rate is often perceived as “cold” and “uncaring.” Reassure the patient and family that early recognition is the key and all tx possibilities are being considered. All tests and studies can be described as a means of early detection, which will allow early intervention for best outcomes. Be honest and reassuring. Even when the patient is sick enough to warrant transfer to the ICU, reassure the patient and family that “the ICU provides the most attentive level of care for the patient’s situation.”

Professionalism

Commitment to Professional Responsibilities
When one is required to transfer a patient to the ICU in the middle of the night, it is appropriate to notify the family representative about the events and transfer. If family members find major events have transpired without their knowledge, they may be dissatisfied with the lack of communication, and resulting fear and mistrust may impact the patient’s care. It is important to keep family members apprised of changes, even in the middle of the night.

A more difficult decision for a resident can be whether or not to notify the attending of the events and transfer. Knowledge of the attending’s practices and preferences, the condition of the patient, and the experience of the resident will determine the necessity of a phone call to the attending. However, for most changes in status like those requiring transfer to the ICU, *attendings will want to know!* If such is *not* the case based on your relationship with the attending, a phone call first thing in the morning is surely appropriate before the attending communicates with the patient or family. *When in doubt, always call.*

Systems-Based Practice

Hospital-wide Operations: Imaging and Diagnostics
Facilitating the completion of studies and patient transfers is often challenging, especially during night shifts. When a patient develops chest pain in the middle of the night and PE is suspected, spiral CT of the chest must be done immediately. Write the order and deliver it to the clerk for computer entry. Notify the patient that the study will be done and obtain consent if necessary. Notify the nurse to help prepare the patient for transport. Phone the respective department or technician to prepare them for a *stat* study. Arranging for transport can be productive, and promptly tracking down the results completes the task. These steps will facilitate a timely study and may even save the patient's life.

Chapter 43
Shortness of Breath (Case 28)

Steve B. Behrens MD, Omar Yusef Kudsi MD, and Catherine L. Kuntz MD, MSCE

Postoperative context: A 69-year-old man develops shortness of breath (SOB) on postoperative day 5 after aortic bifemoral bypass.

Differential Diagnosis

Pulmonary embolism (PE)	Myocardial infarction (MI)	Congestive heart failure (CHF)	Pneumonia	Pneumothorax
Cardiac arrhythmias	Bronchospasm	Upper airway obstruction	Mucus plug	Shock/acidosis

Speaking Intelligently

When approaching a patient with shortness of breath (SOB), it is important to assess the severity of the SOB in a timely fashion because a patient requiring intubation can deteriorate quickly. Numerous clues to the severity of the SOB can be obtained by a focused hx and physical examination. VS and oxygen saturation are mandatory, and auscultation helps determine volume overload or pneumothorax. Since cardiac and pulmonary complications make up most of the differential dx, I obtain an ABG, EKG, and CXR, and give oxygen. Patients without improvement may need to be intubated and transferred to the ICU. If PE is suspected, I consider CT angiography of the chest with PE protocol. When in doubt, I always revert to the ABCs in an acute situation. Assessing the patient and watching the degree to which breathing is labored is invaluable in deciding whether or not to intubate. I also make the effort to show concern and be reassuring to the patient. Involving the patient's nurses in the discussion of the workup and any interventions is beneficial to ensure a team-based approach.

PATIENT CARE

Clinical Thinking

- First and foremost, the decision must be made whether or not the patient needs immediate intubation.
- Once the patient is stabilized, consider the differential dx. R/o the immediate life-threatening cardiopulmonary complications. *MI* can occur anytime, yet frequently presents on POD #2 or #3 after major surgery. Suspicion for *PE* should be high in any surgical patient. Patients with a hx of *CHF* can quickly become volume overloaded even with normal perioperative fluid resuscitation.
- Keep in mind the possibilities. Review of the chart and a focused hx and physical examination should narrow the differential.

History

- Determine the onset, severity, and duration of symptoms. Ask for a hx of prior similar episodes and associated symptoms like chest pain and productive cough or frothy sputum, which may give clues to dx.
- Laryngeal edema usually presents within hours of extubation and is associated with stridor.
- ***PE*** will often present with SOB, and these patients may or may not have a hx of deep venous thrombosis (DVT). Pleuritic chest pain and productive cough suggest ***pneumonia*** or perioperative aspiration.
- ***MI*** is often described as a radiating or crushing chest pain but is often associated with dyspnea and may present without pain, especially in diabetics and in women. A hx of cardiomyopathy or ***CHF*** sensitizes patients to IV fluid and may indicate ***CHF*** exacerbation from volume overload.

- A ***pneumothorax*** is possible after central line insertion, recent thoracic or upper GI surgery, or in an intubated patient.
- A thorough chart review will indicate a hx of prior ***cardiac arrhythmia***.

Physical Examination

- Stop and look. Inspection can often hint at the severity of the acute process. Use of accessory muscles of inspiration in the setting of a process that is not likely to be immediately reversible suggests a need for intubation.
- Assess VS, including pulse oximetry. Hypoxia may accompany all possible entities. Fever is suspicious for ***pneumonia*** or ***PE***. Hypotension may represent massive ***PE***, ***MI***, ***septic shock, tension pneumothorax***, or certain ***cardiac arrhythmias***.
- Auscultation of the heart may reveal new murmurs suggesting an ***MI***, while listening to the rhythm might suggest the presence of ***cardiac arrhythmia***.
- Lung examination with an absence of breath sounds and increased resonance on chest percussion indicates ***pneumothorax***, while absent breath sounds with dullness to percussion suggest a pleural effusion. Diffuse high-pitched expiratory wheezing suggests *bronchospasm*, while lower pitched wheeze over the neck, sometimes louder on inspiration, may indicate *upper airway obstruction*. Rhonchi on auscultation of the lungs may suggest infection or *mucus plugging*, and bilateral crackles may support the dx of a ***CHF*** exacerbation.

Tests for Consideration

- **ABG:** *PE* often presents with respiratory alkalosis, while *bronchospasm* can lead to retention of carbon dioxide; look for systemic *acidosis* as a cause of SOB. **$100**
- **EKG:** Reasonable in *any* patient with SOB; diagnoses most *MI*s and *arrhythmias* (compare the EKG to prior studies). **$150**
- **WBC:** Often elevated in *pneumonia* and other infections. **$30**
- **Hb:** Anemia contributes to cardiac stress. **$30**
- **Electrolytes:** Important to correct in *cardiac arrhythmias; check bicarbonate and anion gap*. **$50**
- **Serial cardiac enzymes (CK, CK-MB, troponin):** R/o cardiac muscle damage. **$115**

IMAGING CONSIDERATIONS

→**CXR:** Portable AP CXRs are notoriously poor quality. Chest PA and lateral is best but requires transport to x-ray. Evaluate for pneumothorax, CHF, PE, atelectasis, pneumonia, pleural effusions, and hemothorax. **$156**

→**CT angiography with PE protocol:** When performed technically well, spiral CT is the fastest, most effective means of evaluating for *PE*. Can also r/o aortic dissection and pneumothorax. Requires IV iodinated contrast, so monitor renal function. **$1050**

→**V/Q scan:** Ventilation/perfusion nuclear scan is useful in cases of renal insufficiency or iodinated contrast allergy as an alternative to CT. When patient is mechanically ventilated, only perfusion scan can be performed. V/Q scan is rarely diagnostic and must be paired with clinical suspicion and Doppler results of extremities in most cases. **$600**

→**Echocardiography:** Will demonstrate cardiac dysfunction from *MI* or right ventricular strain pattern in massive PE. **$325**

Clinical Entities — Medical Knowledge

Pulmonary Embolism

See Chapter 42, Chest Pain (Case 27).

PE occurs when a blood clot lodges in the lumen of a pulmonary artery, causing significant respiratory and sometimes hemodynamic dysfunction and is discussed in Chapter 42. **See Sabiston 15, 59; Becker 36.**

Myocardial Infarction

See Chapter 42, Chest Pain (Case 27).

MI frequently presents with acute pump failure and resultant SOB. The entity is considered in Chapter 42, Chest Pain (Case 27). Also see Congestive Heart Failure below. **See Sabiston 15, 61; Becker 29.**

Congestive Heart Failure

Pφ ***CHF*** develops when the heart pump is inadequate to meet the body's needs. Poor ejection fraction and increased intravascular volume can lead to fluid accumulation in the lungs and other body tissues (peripheral edema).

TP CHF manifests as SOB, orthopnea, pink frothy sputum, jugular venous distension, and rales.

Dx Dx can be made by the clinical picture, and CXR confirms the dx. Kerley B lines, cardiomegaly, effusions, alveolar edema, and hilar congestion are common on CXR.

Tx Acute tx is aimed at reducing intravascular volume with diuretics and stopping IV fluid. Reduction in preload can be accomplished with morphine or nitrates, and can help quickly to relieve SOB. Further management of CHF sometimes includes inotropes to strengthen the contractility of the heart muscle. **See Sabiston 15, Becker 29.**

Pneumonia

Pφ ***Pneumonia*** is characterized by inflammation of the alveolar parenchyma with secretory congestion caused by bacteria, viruses, or irritants. Surgical patients are susceptible to pulmonary infection, especially if they have baseline lung disease, have aspirated after vomiting or peri-intubation, or were intubated for a prolonged period.

TP Pneumonia presents as chest pain, cough, and fever.

Dx Dx can be made by clinical picture, and CXR and sputum culture can be helpful.

Tx Tx requires early and appropriate antibiotic coverage. Severely ill patients may develop respiratory failure or septic shock and may require intubation. **See Sabiston 15, 59; Becker 5, 10.**

Pneumothorax

See Chapter 42, Chest Pain (Case 27)

Pneumothorax is a consideration in postoperative SOB. It is considered in greater detail in Chapter 42, Chest Pain (Case 27), Chapter 51, Penetrating Chest Injury (Case 34), and Chapter 52, Blunt Chest Trauma (Case 35). **See Sabiston 15, 57; Becker 28.**

Cardiac Arrhythmias

Pφ ***Cardiac arrhythmias*** include any abnormality in the rate, rhythm, or sequence of cardiac activation. Early recognition is important because some arrhythmias are not well tolerated and may lead to sudden death. Any arrhythmia associated with hypotension is dangerous. Patients with a hx of arrhythmia or coronary artery disease are at higher risk for arrhythmia in the perioperative period. These patients can be very sensitive to electrolyte abnormalities.

TP Arrhythmias can produce a pounding or racing sensation in the chest, and secondary hypotension causes lightheadedness and syncope.

Dx Cardiac arrhythmias are first detected by feeling the pulse and auscultating the heart to determine rate and rhythm. A 12-lead EKG during the arrhythmia with comparison to a prior EKG is valuable for accurate dx and tx.

Tx Replace deficient electrolytes and assure adequate oxygenation. Drug therapy is specific for each arrhythmia, and one should follow ACLS guidelines. Having the "crash cart" nearby is recommended. Cardioversion (electrical or pharmacologic) might be necessary in the case of hemodynamic instability or chest pain. **See Sabiston 15.**

Bronchospasm

Pφ ***Bronchospasm*** occurs commonly in the hospital, especially in patients with a previous hx of chronic obstructive pulmonary disease or asthma. It may be precipitated by CHF, infection, new use of beta-blockers, or lack of use of outpatient prescription inhalers.

TP Bronchospasm is often characterized by chest tightness and dyspnea, cough, and difficulty moving air in and out of the lungs.

Dx It can usually be diagnosed on physical examination with diffuse high-pitched musical noises (wheezes) on expiration and sometimes inspiration.

Tx Wheezing can often be managed with bronchodilators alone, but corticosteroids are sometimes needed in persistent cases. If CHF is the cause, diuresis is the preferred tx. If beta-blockers have recently been added to therapy, they may need to be discontinued. **See Sabiston 15.**

Upper Airway Obstruction

Pφ *Upper airway obstruction* may result from complications related to endotracheal intubation, such as airway/vocal cord edema and vocal cord paralysis.

TP *Upper airway obstruction* from laryngeal edema becomes evident shortly after extubation, usually within minutes to hours. Patients often develop stridor and SOB with increased work of breathing.

Dx Dx can usually be made on clinical grounds alone but can be confirmed with laryngoscopy if the dx remains in question.

Tx Aerosolized racemic epinephrine can help, and corticosteroids are used for the first 48 to 72 hours for postextubation stridor. **See Sabiston 15; Becker 12, 64.**

Mucus Plug

Pφ ***Mucus plugging*** can result in obstructive atelectasis, with lack of ventilation of the lung distal to the plugged airway and reabsorption of air from that segment into the bloodstream. This can lead to partial (lobar) or complete unilateral atelectasis depending on the site of obstruction.

TP Mucus plugging presents with dyspnea and hypoxemia, often in a patient who is having excess respiratory secretions.

Dx Dx can be made by physical examination and CXR, which shows consolidation of a portion of lung and segmental volume loss.

Tx Mucus plugging can be treated with aggressive respiratory physiotherapy and mucolytic agents. For severe or refractory atelectasis, bronchoscopy may be required for airway clearance.

Shock/Acidosis

Pφ *Systemic acidosis* from processes such as cardiogenic shock, hemorrhage, sepsis, or ischemic bowel results in decreased tissue perfusion. Metabolic acidosis and systemic inflammation produce tachypnea in an attempt to compensate for acidemia.

TP Other signs include tachycardia, hypotension, and low urine output.

Dx Dx of acidosis can be made by blood gas and chemistries, and the etiology must be established. This includes a search for infection, diabetic ketoacidosis, or ischemia to organs such as the bowel or the heart.

Tx Tx depends on targeting the underlying cause of acidosis. Mechanical ventilation may be required in severe acidosis or in people with underlying lung disease who are unable to maintain a high work of breathing. Surgical patients may suffer from hemorrhagic, hypovolemic, cardiogenic, or septic shock. Fluid resuscitation, intubation, antibiotics, invasive arterial monitoring, and pressor therapy may be indicated. **See Sabiston 5, 15; Becker 11.**

ZEBRA ZONE

a. **Adult respiratory distress syndrome (ARDS):** ARDS is acute lung injury after shock, sepsis, pneumonia, or aspiration. ARDS is characterized by progressive hypoxemia and often hypercapnea from noncardiogenic pulmonary edema, decreased lung compliance, and intrapulmonary shunting. CXR will reveal bilateral infiltrates. Early use of positive pressure ventilation with low tidal volumes and high positive end-expiratory pressure optimizes recruitment of alveoli to maximize oxygenation. **See Sabiston 15, 24, 59; Becker 12.**

b. **Pleural effusions:** Small pleural effusions are frequently seen in the postoperative period and can be managed expectantly with an otherwise normal clinical course. If symptomatic and refractory to diuresis, perform a thoracocentesis. If thick infected exudates (empyema) are discovered or Gram stain or culture is positive, a chest tube should be inserted and IV antibiotics initiated. **See Sabiston 15, 57; Becker 28.**

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
Postoperative pulmonary complications: Observations on their prevention by means of physiotherapy

Authors
Thoren L

Reference
Acta Chirurgica Scandinavica 1954;107(2–3):193–205.

Problem
How can postoperative pulmonary complications be minimized?

Intervention
Chest physiotherapy: incentive spirometry, deep breathing maneuvers, coughing exercises, intermittent positive pressure breathing, and chest physical therapy with postural drainage

Outcome/effect
Instituting chest physiotherapy lowered postoperative respiratory complications by 50% after cholecystectomy.

Historical significance/comments
Landmark study which suggested preoperative initiation of chest physiotherapy can lower pulmonary complications significantly. Have you wondered why we use incentive spirometry?

Interpersonal and Communication Skills

Communicating about the Initiation of Mechanical Ventilation
When a patient develops severe SOB requiring intubation, explain to the patient what is going to happen and why it needs to happen. Describe the steps that will be taken in order to relieve and prevent discomfort. Assess the patient's understanding of what you have explained. When a patient is intubated *unexpectedly*, it is important to communicate this event to the family no matter what time of day or night. Once intubated, the patient should be appropriately sedated, usually to maintain some wakefulness while relieving anxiety and dyspnea. Continuing to talk to the patient following intubation will help put the patient at ease and assist in your assessment, and may minimize the amount of sedation required. The attending in charge and the primary care physician should be notified of the intubation.

Professionalism

Principle of Patient Autonomy; Commitment to Maintaining Appropriate Relations with Patients
Sometimes SOB can be reversed quickly with appropriate medical intervention, but, as discussed above, sometimes the need for mechanical ventilation arises. If mechanical ventilation is recommended, *be sure that this is compatible with the wishes of your patient*. Each case is different. In the setting of acute illness, immediate measures often need to be taken, as long as they are not in opposition to the previously expressed wishes of the patient. Communication with the patient and the family during this time is essential to assure that medical tx fits the needs of the patient and to establish a trusting relationship with the family during this difficult time.

Systems-Based Practice

Working with Nursing and the Patient Care Team
Coordinating care is crucial in the patient who is short of breath, particularly if studies need to be obtained and transport to the ICU is needed. Communicate with all members of the health-care team, as nursing and sometimes physician care will change as the patient arrives in the ICU. If the patient is experiencing an MI, for example, take personal responsibility in consulting the cardiology service and in communicating directly with other members of the health-care team. There is no better way to assure that communication with the nursing staff is thorough and accurate than by direct conversation with the individuals who will be assuming the patient's care.

Chapter 44
Postoperative Fever (Case 29)

Charles Shieh MD, Julia Bulatova MD, and Mary Ann Hopkins MPhil, MD

Postoperative context: A 52-year-old female presents with fever on postoperative day 3 after small bowel resection for obstruction with reanastomosis.

Differential Diagnosis — Medical Knowledge

Infectious Causes				
Atelectasis/ pneumonia	Urinary tract infection (UTI)	Surgical site infection (SSI)	Line-related infection	Intra-abdominal abscess/ anastomotic leak

Noninfectious Causes		
Drug-induced fever	Deep venous thrombosis (DVT)	Blood product reaction

Speaking Intelligently

When a patient spikes a postoperative temperature of greater than 100.4°F, an immediate bedside evaluation is required. First, I obtain a thorough hx and perform a physical examination related to the patient's surgery and hospital course. A focused assessment should include VS, O_2 sat, and evaluation of lungs, abdomen, the incision site, catheter sites, and extremities. The fever workup includes wound assessment, CXR, and blood and urine tests, including a CBC, U/A, and blood cultures.

Think of five common causes of postoperative fever—("the 5 W's"):

Wind	Atelectasis, pneumonia
Wound	Surgical site infection
Water	UTI
Walking	DVT, PE, phlebitis at IV site
Wonder drug	Drug reactions

PATIENT CARE

Clinical Thinking

- Look first for life-threatening problems that might need rapid tx such as necrotizing *SSIs*, which are diagnosed by careful wound inspection.
- If *PE* is suspected, spiral CT should be performed; PE requires urgent anticoagulation.

History

- Onset and duration of fever are most important. Associated symptoms (e.g., pain, dyspnea, cough, and diarrhea) may give clues and will direct your workup.
- Fever within 48 hours of surgery is common and usually not due to an infectious etiology.
- Fever on POD #5 to #10 may indicate an *SSI*, an intra-abdominal abscess, or an anastomotic leak in GI tract surgery.
- The perioperative course should be reviewed: a difficult intubation should make you suspicious for *aspiration pneumonia*; prior hx of a *DVT* or coagulation disorder may suggest a high risk for *PE*.

Physical Examination

- VS and oxygen concentration can be labile with fever, but may be early signs of *sepsis*.
- Inspect for wound erythema, purulent drainage, and crepitus, which may indicate *SSI*.
- Extremities should be examined for unilateral edema, suggesting *DVT*.

- Inspect catheter sites for erythema and purulent drainage.
- Auscultate the lungs: crackles, rubs, or decreased lung sounds may suggest *atelectasis* or *pneumonia*.

Tests for Consideration

- **CBC + differential:** Confirm likely infection. **$57**
- **U/A:** Check for leukocytes and nitrites. **$38**
- **Blood cultures:** Two separate sites for bacteremia. **$100**
- **Sputum culture:** To identify bacteria **$100**

IMAGING CONSIDERATIONS

→**CXR:** PA and lateral to evaluate for pneumonia and/or atelectasis. Postoperative free air may be present for up to a week. **$125**

→**CT abdomen/pelvis:** The most effective means to evaluate for postoperative intra-abdominal complications. Requires oral and IV contrast. Consider water-soluble gastrograffin oral contrast if suspicious of anastomotic leak. **$850**

→**Spiral CT with PE protocol:** In case of high suspicion of *PE* **$1,200**

→**V/Q scan:** Alternative to CT for high-suspicion *PE* **$600**

→**Doppler ultrasonography of lower extremity veins:** Real-time scanning of the deep veins through the thigh and knee compressing the lumen of the vein to evaluate for thrombus. Can be performed at bedside. Preferable over seldom used venography. **$850**

Clinical Entities — Medical Knowledge

Atelectasis

Pφ Atelectasis is one of the most common causes of fever during PODs #1 and #2. Hypoinflation of alveoli may occur with mechanical ventilation during surgery and poor respiratory effort afterward.

TP The patient often has fine bibasilar crackles on physical examination and poor clearance of respiratory tract secretions. X-rays may be negative unless the problem is severe. Those

	patients at increased risk include smokers, chronic pulmonary disease patients, the obese, and patients with upper abdominal or chest incisions.
Dx	CXRs are not highly sensitive for atelectasis. Fevers are low grade and should clear with incentive spirometry, upright positioning, increased ambulation, and inhalers to help clear secretions. If fever and respiratory symptoms continue, pneumonia must be considered. **See Sabiston 15, Becker 10.**

Pneumonia	
Pφ	Pneumonia is an infectious inflammation of alveoli with accumulation of exudate caused by bacteria, viruses, or fungi.
TP	Manifestations are productive cough, chest pain, and fever. Aspiration pneumonia is a chemical pneumonitis often related to difficult intubation or vomiting. Bacterial pneumonia can also result from poor pulmonary ventilation and/or secretion clearance.
Dx	Pneumonia is diagnosed by hx, physical examination, and CXR. Sputum or blood cultures may identify the organism.
Tx	Treat with appropriate antibiotics and respiratory support. Bronchoscopy and bronchoalveolar lavage may be indicated in severe cases. **See Sabiston 15, 59; Becker 5, 10.**

Urinary Tract Infection	
Pφ	UTIs tend to occur slightly later in a typical postoperative course (usually POD #4 and beyond), but can appear at any time. They are common in patients who have had a Foley catheter in place pre- or postsurgery. For this reason, urinary catheters are removed as soon as possible after surgery.
TP	Symptoms of dysuria and frequency are not always present.
Dx	U/A (looking for WBCs) and urine cultures should be part of any postoperative fever workup.
Tx	Tx depends on the specific organism. **See Becker 10.**

Surgical Site Infection

Pφ/TP *Wound infection* typically manifests itself on PODs #4 to #6. Risk factors include abdominal or emergency surgery, significant dead space within the wound, hematoma, tissue ischemia, foreign bodies, diabetes, morbid obesity, and malnutrition.

Dx The surgical wound should be inspected daily for erythema, drainage, and increased tenderness. A wound infection in the deeper tissue planes may not manifest externally.

Tx If infection is strongly suspected, the wound should be opened, cleaned, and packed with gauze. **Wound infection and wound complications are considered in greater detail in Chapter 46, Wound Complications (Case 31). See Sabiston 14, 15; Becker 10.**

Line-Related Infection

Pφ/TP IV sites can become erythematous, indurated, and tender. This local reaction may be due to inflammation and/or infection. Simple noninfectious phlebitis is benign and should resolve with removal of the catheter. An infectious process is of greater concern as IV lines have direct access to the circulation, especially central IV lines in the subclavian and internal jugular veins. Skin bacteria (*Staphylococcus* and *Streptococcus*) are the most commonly associated organisms.

Dx/Tx If line sepsis is suspected, all IV lines should be changed to new sites. Catheters tips should be cultured, and blood cultures drawn. The best prevention against catheter infections is strict adherence to sterile technique whenever central lines are inserted or manipulated. **See Sabiston 14, 15; Becker 10.**

Intra-abdominal Abscess/Anastomotic Leak

Pφ In the realm of general surgery, intra-abdominal abscess usually occurs either when there has been gross contamination of the abdominal cavity by the initial disease process (e.g., perforated viscus) or when there has been contamination related to the nature of the surgery performed (e.g., colectomy). When a patient has undergone a bowel anastomosis, anastomotic leak must always be considered. Anastomotic leaks usually manifest themselves after the 4th postoperative day.

TP The typical patient has fever, leukocytosis, increasing abdominal tenderness (unexplained by the recent incision), persistent ileus, and abdominal distention.

Dx If abscess or anastomotic leak is suspected, CT scan of the abdomen and pelvis is the best diagnostic test and should be performed urgently. Always consider that what appears to be a presentation of shortness of breath may represent sepsis due to an anastomotic leak.

Tx Whereas an intra-abdominal abscess may be treated with percutaneous drainage under CT guidance, anastomotic leaks almost always require prompt return to the operating room.

Deep Venous Thrombosis

Pφ DVT is often related to venous stasis from immobility in the perioperative period. The deep veins of the lower limbs and pelvis are the most commonly affected.

TP The most common sign is limb swelling. Other clues are tenderness, pain, and erythema. Homan's sign (pain in the calf upon dorsiflexion of the ankle) tends to be an inconsistent finding.

Dx The key to dx is to pay attention to risk factors: prior hx of DVT, obesity, immobility, pelvic and orthopedic procedures, cancer, hypercoagulable state, and peripheral venous disease. Doppler ultrasonography is the best test for dx.

Tx Tx of DVT necessitates anticoagulation intravenously (heparin), usually followed by oral warfarin tx. Patients with recurrent PEs and lower extremity DVT already on prophylaxis or those with contraindications to anticoagulation need an IVC filter. **See Sabiston 15, 68; Becker 36.**

Blood Product Reaction

TP ***Febrile nonhemolytic transfusion reaction:*** most common adverse reaction to a blood transfusion. Presents as fever and dyspnea 1 to 6 hours following transfusion; clinically benign, no lasting side effects.

Acute hemolytic reaction: a true emergency usually caused by administration of the wrong unit to the wrong patient (see the M & M box, Case 27) when RBCs are destroyed by host antibodies; presents as fever, chills, back pain, and myoglobinuria leading to acute renal failure.

Anaphylactic reaction: severe allergic reaction can occur (patients usually have an unknown IgA deficiency) at a rate of 1 per 30,000–50,000 transfusions.

Transfusion-associated acute lung injury (TRALI) is a syndrome of acute respiratory distress often associated with fever, noncardiogenic pulmonary edema, and hypotension. Symptoms are mild to life-threatening, but most patients recover fully within 2–3 days; mortality rate can be as high as 10%.

Dx Dx is by suspicion based on recent transfusion and exclusion of other common causes of postoperative fever.

Tx Tx is immediate cessation of blood product delivery and supportive care

Drug-Induced Fever

Pφ Fever after drug administration can be caused by systemic hypersensitivity or by local inflammation at the injection site (phlebitis, abscess). Drugs or their delivery systems may contain pyrogens or microbial contaminants. Certain drugs may specifically produce fever (e.g., thyroxine), limit heat dissipation, or alter thermoregulation (e.g., phenothiazines, antihistamines). Fever is most often associated with antimicrobials (beta-lactam antibiotics), antihypertensives (methyldopa), antiarrhythmics (procainamide), and antiepileptic drugs (phenytoin).

TP Fever may occur days after a drug has been administered and may last for days after the drug has been discontinued. Rash and eosinophilia occur in only a small percentage of cases.

Dx The dx of drug-induced fever is a dx of exclusion and is established by a temporal relationship between drug initiation and fever.

Tx Tx is cessation of drug administration. **See Sabiston 15.**

ZEBRA ZONE

a. **Alcohol withdrawal:** High-grade fevers may accompany alcohol withdrawal, especially when withdrawal is associated with visual hallucination. This may occur from 1 to 14 days after alcohol cessation.

b. **Sinusitis:** Sinusitis may occur in patients with prolonged intubation or NG tube maintenance. This infection is diagnosed by clinical heavy nasal secretions and air-fluid levels in the sinuses on CT. Tx requires antibiotics and sometimes sinus drainage.

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
The value of postoperative fever evaluation

Authors
Freischlag J, Busuttil RW

Reference
Surgery 1983;94(2):358–363

Problem
How useful and cost effective is routine fever workup? How do the results of the ordered tests impact on dx and tx?

Intervention
None

Evidence
Retrospective chart analysis of 71 patients with postoperative fever out of 464 patients who underwent abdominal operations.

Outcome/effect
Only 27% of patients had a culture-proven infection. 74% of those patients had the dx made by clinical findings and a single appropriate test. Unnecessary tests led to an excess expenditure of $19,738.

Historical significance/comments
This article emphasizes that postoperative fever is most commonly not from an infectious source. This early study also stresses the importance of the hx and physical examination in directing a focused approach in the assessment of postoperative fever, significant particularly in this era in which health-care resources are not unlimited.

Interpersonal and Communication Skills

Empathy Is an Acquired Skill
The postoperative period, particularly when the spectre of a postoperative complication has arisen, is a time when it is necessary to demonstrate empathy. Empathy, the ability to identify and understand another's feelings or difficulties, is a behavior, not an emotional state. The ability to demonstrate empathy can be learned. Below are a few statements that you can use to exhibit empathy toward your patients:

- It sounds like you are really scared. That's a perfectly natural reaction.
- You have a lot to deal with right now. I know that must be hard.
- I understand how you feel.

Professionalism

Commitment to Improving Quality of Care
When multiple concurrent infections occur in an ICU setting, one must investigate the infecting organisms to determine the cause of the "ICU epidemic." Whether the "epidemic" should trace back to a *Staphylococcus* carrier or to a *Pseudomonas* infection related to improper maintenance of respirator equipment, one must have the commitment to evaluate processes and outcomes in order to improve care.

Systems-Based Practice

Patient Safety: Within the Surgical Suite
Postoperative fever is a common occurrence on the surgical service. However, should multiple patients develop a similar pattern of postoperative infectious problems, further investigation may be warranted. For example, if a hospital experiences an unexplained increase in the number of postoperative wound infections, it may be helpful to examine the OR procedures to uncover any lapses in sterilization techniques. Is the temperature adequate on the autoclave? Is the ventilation system in the OR working properly? Are there new OR personnel and have they been taught proper sterilization techniques? If a specific microorganism appears to be prevalent, it may be useful to investigate whether the antibiotic regimens used are effective. Inadequate antibiotic coverage is a common reason for failure to resolve infections. Broad administration of antibiotics can also be problematic because such a practice may lead to resistant strains. Surgical morbidity and mortality conference is an excellent setting to uncover patterns and discuss proposals to address these issues.

Chapter 45
Low Urine Output (Case 30)

Gregory Peck DO, Umber Burhan MD, and Robert L. Benz MD

Postoperative context: A 58-year-old male with a past medical hx of coronary artery disease has a 1-day hx of low urine output after open cholecystectomy for acute cholecystitis.

Differential Diagnosis

Prerenal (Hypoperfusion)	Renal (Intrinsic)	Postrenal (Obstructive)
Hypovolemia	Acute tubular necrosis (ATN)	Urinary retention
Shock syndromes	Acute interstitial nephritis (AIN)	Benign prostatic hypertrophy (BPH) and ureteral ligature

Speaking Intelligently

My first step in assessing postoperative oliguria is to acquire a relevant hx. This includes knowing the patient's baseline health levels (preoperative creatinine) and any recent medication exposure (nephrotoxins). I check VS for hypotension, tachycardia, and any imbalance in "ins" and "outs" (including insensible losses). I check operative reports for the procedure, complications, intraoperative fluids, blood loss, and blood products administered. I compare the patient's urine output to an *adequate* urine output of 0.5 mL/kg/hr. Next, I make sure that the patient is receiving adequate fluids based on deficit and clinical setting. If I have a suspicion of a postrenal cause, I obtain a bladder scan or insert a Foley catheter to check for obstruction and to monitor urinary response to my interventions. Renal ultrasonography will help r/o hydronephrosis.

PATIENT CARE

Clinical Thinking

- Since the kidney receives 20% of cardiac output, urine output is in part a reflection of that cardiac output. Similarly, it is an indirect measure of intravascular volume status. Decreased urine output is *not* a dx, but rather a symptom of hypoperfusion, intrinsic renal injury, or postrenal obstruction.
- The causes of decreased urine output fall into one of three categories: ***prerenal, intrarenal***, and ***postrenal*** pathology.
- The most common ***prerenal*** etiology is **hypovolemia,** diagnosed clinically in the setting of oliguria, hypotension, tachycardia, and dry mucous membranes. Oliguria due to hypovolemia should correct with appropriate volume replacement. Typically creatinine increases less than 0.1 to 0.3 mg/dL/day.
- The most common ***intrarenal*** etiology is ATN, usually due to ischemia or toxin exposure. ATN is usually sudden in onset and worrisome because of its severity and potential for irreversible damage. Typically creatinine increases greater than 0.5 mg/dL/day.

- The most common ***postrenal*** etiology is obstruction, either mechanical or physiologic, and is usually due to urinary retention, prostate disease, and/or nephrolithiasis.
- If the patient is already catheterized, verify that the catheter is working properly.
- Check that the patient isn't voiding in the bathroom without record, or if the patient isn't already known to have anuria from end-stage renal disease.

History

- Ask about orthostatic syncope, dizziness, and thirst.
- Inquire about suprapubic fullness, which may suggest a bladder etiology such as retention, and dysuria or difficulty voiding, which may suggest prostate disease or UTI.
- A relevant PMH searches for coronary disease, previous infarction, hypertension, previous renal disease, autoimmune disease, prostate and bladder problems, allergies to medications, and recent dye studies in preoperative and intraoperative radiographic studies.
- Review the medications received prior to the oliguric state. Determine exposures to medications such as NSAIDs, angiotensin-converting enzyme (ACE) inhibitors, angiotensin II receptor blockers, and general anesthetics.
- Assess intake and output. ***Regarding intake***: Is the patient NPO? Poor appetite? Has volume been inefficiently maintained? ***Regarding output***: Did the patient undergo a bowel prep? Has there been vomiting, diarrhea, sweating? Is the patient on diuretics?
- Remember that preoperative issues impact on volume status in the postoperative setting.

Physical Examination

- VS and intake/output: Temperature, pulse, BP, central venous pressure (CVP), pulmonary capillary wedge pressure (PCWP), if available, for signs of hypovolemia.
- Appearance: Suspect hypovolemia if pale, sunken eyes, dry mucous membranes, decreased skin turgor, and dry axilla.
- Chest: Jugular venous distention (JVD), crackles and peripheral edema for congestive heart failure.
- Abdomen: Bladder distention and abdominal bruits.
- Surgical: Look for drainage output, incisional losses, possible sources for sepsis.
- Rectal examination: Prostatic hypertrophy.
- Miscellaneous: Check if Foley catheter is properly inserted and not kinked or blocked. Is the IV catheter functioning?

Tests for Consideration

- **Serum and urine creatinine levels:** This ratio determines whether the etiology is likely prerenal (U/P creatinine > 60) or ATN (ratio < 40) and is a factor in formulating the FE_{Na} (fractional excretion of sodium). **$100**

- **Urine electrolytes and U/A:** Specific gravity and urinary sediment (i.e., casts); differentiate between prerenal and intrinsic renal failure. **$200**
- **BUN/creatinine (BUN/Cr) ratio:** >20 : 1 is prerenal and <20 : 1 is intrarenal. **$45**
- **EKG and cardiac enzymes:** Cardiogenic shock. **$115**
- **CVP, systemic vascular resistance (SVR), and PCWP:** Differentiate the different types of shock (i.e., hypovolemic, septic, and cardiogenic). **$500**
- **Blood, wound, and urine culture with Gram stain:** If suspected source of sepsis. **$300**

IMAGING CONSIDERATIONS

➔**Bladder scan:** Limited ultrasonography of the bladder to r/o urinary retention. Easy to perform at bedside. **$225**

➔**CXR:** Evaluate for pulmonary edema and volume depletion through third spacing into the lungs. **$150**

➔**Renal ultrasonography:** Request evaluation of hydronephrosis and urinary tract obstruction. Ultrasonography can give clues to intrinsic kidney disease by evaluating size and echogenicity of kidneys: "medical renal disease." **$250**

Clinical Entities — Medical Knowledge

Prerenal (Hypoperfusion)

Pφ ***Hypovolemia*** is the most common cause of oliguria. It results in hypoperfusion and is usually due to inadequate volume maintenance, resuscitation, and/or repletion. Third space loss due to hypoalbuminemia or tissue injury may add to intravascular volume depletion. Decreased intravascular volume leads to decreased renal blood flow and decreased glomerular filtration. Tubules reabsorb more water and sodium, and decreased urine output results. Shock also results in hypoperfusion. ***Cardiogenic shock*** leads to hypoperfusion due to low cardiac output. ***Septic shock*** is characterized by peripheral vasodilatation and increased vascular permeability, which lead to renal hypoperfusion. Both hypovolemia and shock cause a prerenal acute renal failure (ARF). The U/A shows no granular casts.

TP The typical postoperative patient with hypovolemic, cardiogenic, or septic shock is hypotensive and tachycardic. What differentiates these types of shock is context and physical findings; noninvasive tests and measurement of cardiac and systemic circulatory parameters may be required.

Hypovolemia

- *Context*: Typically following lengthy intra-abdominal case with long OR exposure, large insensible losses, possible fluid shifts, and inadequate replacement.
- *Exam*: mucous membranes may be pale and dry.

Cardiogenic Shock

- *Context*: MI in an older patient with CAD or DM
- *Exam*: “cold shock,” i.e., cold extremities + jugular venous distention (JVD), rales, edema, S3, SOB, orthopnea.

Septic Shock

- *Context*: after surgery on a perforated viscus.
- *Exam*: “warm shock,” warm extremities, fever (generally), no JVD, no rales.

Dx ***Hypovolemia***

- Check Hb/Hct to r/o hypovolemia secondary to postop bleeding

Cardiogenic Shock

- Check for EKG changes, ↑ enzymes, pulmonary edema on CXR, hypokinesis on echocardiogram.

Septic Shock

- Check cultures of blood, lungs, urine, wounds; infiltrate on CXR.

Using the CVP catheter or Swan-Ganz catheter to help differentiate

To differentiate hypovolemic, cardiogenic, and septic shock, central venous monitoring may be warranted to gauge CVP; a Swan-Ganz catheter may be indicated for additional useful parameters (SVR, CI, and PCWP), particularly when sorting out cardiogenic vs. septic shock. The characteristic values in each clinical picture are as follows:

State	CVP	SVR	CI	PCWP
Hypovolemia	↓	↑	↓	↓
Cardiogenic	↑	↑	↓	↑
Septic	↓	↓	↑	↓ or nl

For all ***prerenal*** causes of hypoperfusion:

- Urinalysis shows no casts
- Specific gravity > 1.015
- Fractional excretion of sodium (FE_{Na}) is <1*
- BUN/Cr ratio > 20
- $U_{Na} < 20$

$$FE_{Na} = \frac{(\text{urine Na/plasma Na})}{(\text{urine Cr/plasma Cr})} \times 100$$

Tx ***Hypovolemia***

- Fluid replacement

Cardiogenic Shock

- IV fluids (judicious if patient is in CHF)
- β_1-Agonists increase inotropic effects and contractility. Drugs such as milrinone and dobutamine stimulate cardiac output.

Septic Shock

- IV fluids
- Antibiotics
- Removal of septic source: e.g., drainage of abscess, resection of ischemic bowel, debridement of infected wound
- Vasopressors such as vasopressin and levophed for pressure support

See Sabiston 15, Becker 10

*Note: Diuretics and normal saline (IVF) may make Fe_{Na} unreliable

Intrinsic Renal Failure: Acute Tubular Necrosis (ATN)

Pφ/TP ATN results from either severe or prolonged renal ischemia or toxin exposure. It is characterized by destruction of tubular epithelial cells and subsequent acute renal dysfunction from intraluminal obstruction of tubules and back-leak into the renal interstitium. Impeded urine outflow leads to decreased urine output. IV dye specifically causes hyperosmolar injury to the endothelium of small vessels and oxidative injury to renal tubular epithelial cells. ATN typically follows long or complicated surgery with blood loss or hypotensive episodes that manifest as postoperative oliguria. Increase in serum creatinine is usually rapid. Rhabdomyolysis from compartment syndrome may result in ATN due to myoglobin toxicity in the kidney. IV dye studies performed preoperatively/intraoperatively should be considered etiologies for ATN in the postoperative period.

Dx Urinary sediment may reveal granular casts, which represent necrotic tubular cells. BUN/Cr ratio is <15 : 1. U_{Na} is >40 mEq/L and FE_{Na} is >2% with intrarenal ARF. Dialysis may be indicated when hyperkalemia, volume overload, or uremic symptoms are present.

Tx Tx (if one exists) consists of stopping the offending agent and hydration. **See Sabiston 15.**

Intrinsic Renal Failure: Acute Interstitial Nephritis (AIN)

Pφ/TP AIN is an allergic reaction that occurs most commonly from antibiotics and other medications such as NSAIDs. AIN consists of interstitial inflammation and tubular damage in the nephron. It is usually related to the administration of offending medications and presents as a triad of fever, maculopapular rash, and oliguria.

Dx U_{Na} is >40 mEq/L and FE_{Na} is >2% with intrarenal ARF. Eosinophils and white cell casts will be identified by urine microscopy. Percutaneous renal biopsy will confirm the dx with the presence of interstitial inflammation and eosinophils.

Tx Tx requires discontinuation of the offending agent and hydration. Steroid therapy may reduce the duration and severity of the inflammatory process. **See Sabiston 15.**

Postrenal (Mechanical Obstruction)

Pφ/TP A blockage distal to the renal parenchyma (upper) or lower urinary system that can cause a postrenal ARF. The calyces, ureters, bladder, prostate, and urethra are all possible locations for obstruction. Urinary retention and BPH are the most common causes of postrenal ARF. Iatrogenic ligature of the ureter (accidentally tying off the ureter) during intra-abdominal surgery would cause ARF and may present as oliguria if the patient has only one functioning kidney to begin with. Oliguria with suprapubic fullness is likely to represent urinary retention. Oliguria with gross hematuria, inability to urinate, and/or a slowed urinary stream may represent BPH.

Dx Renal ultrasonography is the gold standard for identifying an obstruction in the urinary system. If the obstruction is significant, hydronephrosis will be present. Cystoscopy may help to identify the specific cause of the obstruction (stones or extrinsic compression). In the elderly male patient with a hx of

BPH or neurogenic bladder, both postvoid residual (ascertained by bladder scan) and insertion of a Foley catheter quantifies the degree of urinary retention.

Tx Tx depends on the etiology. Alpha-blockers for BPH may suffice. Ureteral cytoscopy with ureteral stenting may be necessary. If the lower tract is obstructed, a "straight cath" is both a diagnostic and therapeutic tool. **See Sabiston 15.**

ZEBRA ZONE

a. **"Document error"** may be misconstrued as decreased urine output. Recording errors occur frequently. Patients may have voided in the bathroom or in bed, so recorded urine output is inaccurate.

b. **Obstructed Foley catheter:** The catheter may have a kink or clot obstructing its lumen. Simple readjustment of the catheter position or a saline flush can be corrective.

Practice-Based Learning and Improvement: Morbidity and Mortality Self-Assessment Form

Complication	Contrast reaction with ATN
Type	Adverse reaction to medication; probably preventable
Surgery performed	None; ATN occurred following CT performed with IV contrast.
Patient's disease	61-year-old man with severe biliary pancreatitis and suspected pancreatic necrosis
Presentation	Persistent rise in creatinine immediately following CT
Intervention	Dialysis
Outcome	Requires dialysis; outcome uncertain
Risk factors	Creatinine 1.6 prior to CT
How were risks addressed?	Patient was well hydrated prior to scan; there were no other contraindications to contrast.

What happened?	Rise in serum creatinine from 1.1 to 2.3 the next morning.
What could have been done differently?	Could have considered MRI instead of CT or CT with oral contrast only.
Would outcome have been different?	Dialysis would have been avoided.

Interpersonal and Communication Skills

When Health Literacy Is Diminished

Postoperative oliguria, its potential etiologies, workup, potential treatments, and prognoses can be a complicated discussion with patients and families. When talking to a patient or family whose health literacy is diminished, speak slowly and in simple language (e.g., "work of the kidneys," not "renal function"). Avoid overwhelming the patient with more information than he or she can handle.

The U.S. Department of Health and Human Services notes the impact of diminished health-care literacy in three patient-related arenas: (1) *clinically*—as in following dosing directions and instructions for self-management; (2) in matters of *prevention*—relating to the ability to develop and maintain healthy lifestyle practices and recognize and respond to symptoms of health-care problems; and (3) in an individual's ability to navigate the broader health-care system, relating to matters of benefit coverage and noncoverage, referrals, eligibility for Medicaid, and the meaning of informed consent. Be alert to these limitations in your patients and develop strategies and tap health literacy resources to help you compensate for possible communication deficits.

Professionalism

Commitment to Professional Responsibilities

Study findings reported in the *New England Journal of Medicine* demonstrated that "physicians disciplined by state medical boards during their professional careers were three times more likely than their colleagues to have exhibited unprofessional behavior while in medical school."[1]

Behaviors for which physicians were disciplined included use of drugs or alcohol, unprofessional conduct, conviction of a crime, and negligence. Unprofessional behavior in medical schools is the strongest risk factor for later disciplinary action by a state medical board. Unfortunately, medical students who exhibit unprofessional behavior are rarely introspective enough to self-assess and seek counseling; recognizing such a problem in a fellow student should prompt encouragement to seek counseling. This is a professional responsibility.

Systems-Based Practice

Medical Waste and Unnecessary Care

A 77-year-old woman was admitted because of 3 days of vomiting and diarrhea. The severity of her state of dehydration was not appreciated, and because she had a past hx of congestive heart failure, her IV rate was written for only 50 mL/hr. After 24 hours, her oliguria turned into ARF and she now requires dialysis at an obvious cost to her quality of life and at a significant financial cost.

It is estimated that billions of dollars are wasted every year in the United States on unnecessary care. Unnecessary care falls into four categories:

1. Inefficiencies in the system, such as the lack of electronic medical records leading to tests and imaging studies being needlessly repeated.
2. Patient safety problems causing patients to spend extra days in the hospital, be readmitted, and suffer needless pain and risk.
3. The risk for malpractice suits causing the practice of "defensive medicine"—the overuse of diagnostics in an effort to prevent potential litigation.
4. Failure to effectively communicate with patients and their families resulting in futile efforts to prolong a patient's life.

Physicians can reduce unnecessary health-care costs by identifying sources of wasteful spending, and by making careful and prudent efforts to reduce them.

Reference

1. Papadakis MA, et al.: Disciplinary action by medical boards and prior behavior in medical school. N Engl J Med 2005.

Chapter 46
Postoperative Wound Complications (Case 31)

Gabriel Del Corral MD, Larry Jonas MD, and Leo A. Gordon MD

Postoperative context: A 32-year-old man 5 days after exploratory laparotomy for a gunshot wound to the abdomen with increased incisional drainage.

Differential Diagnosis

Hematoma	Seroma	Enterocutaneous fistula
Superficial wound infection	Dehiscence/evisceration	Necrotizing fasciitis

Speaking Intelligently

When I am called about a postoperative wound matter, reviewing the details of the operative procedure permits me to evaluate the wound intelligently. Before examining the wound, I check the VS and temperature, communicate with the nursing staff about the details of the wound care, and verify the presence and function of drains or special wound management.

PATIENT CARE

Clinical Thinking

- Evaluate the patient for signs of systemic infection, local infection, or unexpected wound drainage. R/o wound complications that might require immediate surgical attention.
- ***Dehiscence*** occurs when a surgically closed wound or scar separates.
- ***Evisceration*** implies that the skin has opened and intra-abdominal contents are exposed. This complication requires immediate stabilization at the bedside and, in most cases, exploration and closure in the OR.
- ***Necrotizing fasciitis*** is a serious wound infection that spreads quickly. Tx necessitates urgent wide surgical debridement and broad-spectrum antibiotics.

- ***Superficial wound infections*** usually require bedside wound exploration to allow adequate drainage.
- Surgical wounds heal by primary intention, by secondary intention, or by delayed primary closure. Apposed skin edges held together by sutures or staples heal by primary intention. A wound left open to granulate over time is healing by secondary intention. Delayed primary closure involves apposing the wound edges after a few days of a wound left open. It has been shown this delay in wound closure increases the tensile strength of the wound and resistance to infection.

History

- Review the details of the surgical procedure. Review the method of closure (staples or sutures, retention sutures, open packing, drains, etc.).
- Determine the timing of the complication in relation to surgery. Foul-smelling serous drainage with crepitus in the first 12 hours may indicate ***necrotizing fasciitis***. Salmon-colored fluid draining within the first week after abdominal surgery implies ***wound dehiscence***. Drainage suggestive of intestinal contents is probably an ***enterocutaneous fistula***, which can present from days to weeks following abdominal surgery.
- Risk factors for wound complications include malnutrition, steroids, obesity, smoking, diabetes mellitus, ischemia, infection, a technically inadequate method of wound closure, and emergency or multiple surgeries.

Physical

- Dressings should be changed daily. Inspect the wound for surrounding erythema, skin breakdown, bleeding, or obvious drainage. Characterize and quantify drainage.
- Palpate the wound gently to elicit skin blanching, tenderness, crepitus, or drainage. The four classic signs of wound infection are redness, swelling, heat, and pain (in Latin: *rubor, tumor, calor, dolor*). Pain is the most sensitive indicator of infection.
- Wounds should not be opened casually when ***wound dehiscence*** is suspected. ***Hematomas*** and ***superficial wound infections*** may require exploring the wound more deeply but should proceed only under direct senior instruction or supervision.

Tests for Consideration

- **WBC:** Can be elevated in wound infection. **$30**
- **Hb:** Can be decreased in large *hematomas*. **$45**
- **Gram stain and wound culture:** Particularly when clostridia (gram-positive rods) are suspected; antibiotic sensitivities are important. **$100**
- **Albumin/prealbumin:** Assess nutritional status. **$66**

IMAGING CONSIDERATIONS

➔**Obstruction series:** Erect CXR and two-view abdominal plain film. Postoperative free air may be present for up to a week. Look for gas in the soft tissues. **$150**

➔**CT abdomen/pelvis:** The most effective means to evaluate for postoperative intra-abdominal complications. Requires oral and IV contrast. Consider water-soluble gastrograffin oral contrast if suspicious of bowel leak. Extravasation of oral contrast into the wound confirms *enterocutaneous fistula*. **$850**

Clinical Entities — Medical Knowledge

Hematoma

Pφ **Hematoma** is generally the result of inadequate intraoperative hemostasis and occurs not infrequently in patients who are anticoagulated in the perioperative period.

TP Hematoma may present as bloody wound drainage or an expanding mass and is a clinical dx made at the bedside.

Tx Tx is usually supportive with pain control, ice packs, and local compression. Expanding hematomas that are extremely painful or compromise hemodynamics from compression or blood loss necessitate operative evacuation. Failure to identify the source of a hematoma is not unusual. Due to the potential for airway compromise, neck hematomas should be considered for emergent return to the OR for evacuation and hemostasis. As blood is also an excellent medium for infection, hematomas in contaminated fields should be evacuated. **See Sabiston 15, Becker 8.**

Superficial Wound Infection

Pφ **Superficial wound infection** is a local infection in the subcutaneous tissues of the incision. Wounds are classified by the risk for contamination. The risk for wound infection increases exponentially by case classification.

	Clean	Clean-contaminated	Contaminated	Dirty
Infection risk	<2%	4%–10%	>10%	100%
Surgery	Skin, breast, hernia	Bowel, lung, gynecological, oropharynx	Penetrating trauma with spillage, gross spillage of bowel contents	Active infection already present, abscess
Microorganism	*Staphylococcus aureus*	Endogenous flora (*Escherichia coli*, *Bacteroides*, gram-negative)	Exogenous flora (*E. coli*, *Bacteroides*, gram-negative)	Prior culture or multiple microorganisms

TP Perioperative risk factors include obesity, hypothermia, hypoxia, ischemia, smoking, and diabetes. A superficial infection may manifest with erythema, tenderness, or purulent wound drainage and can be associated with fever or leukocytosis.

Dx Dx is made by clinical assessment. The need for wound culture depends on the clinical context. (When in doubt, obtain a culture.)

Tx Tx involves draining the infection by opening the incision. Antibiotics depend on the clinical context. Evidence indicates that wound infections are best prevented by preoperative antibiotics within 1 hour of incision. **See Sabiston 14, 15; Becker 10.**

Seroma

Pφ A **seroma** is a pocket of clear serous fluid that develops after surgical dissection after disruption of lymphatic channels, which leak into a closed space.

TP Seromas are particularly common after hernia mesh repairs, after axillary and inguinal dissections, and after raising skin flaps for plastic surgery.

Dx Dx is by clinical examination of the wound. When necessary, can be confirmed by simple needle aspiration.

Tx 90% of seromas will resorb within 6 weeks and should be left alone. Symptomatic, persistent, or infected seromas will require aspiration and drainage. Antibiotics are indicated only if infection is suspected. **See Sabiston 15, Becker 9.**

Wound Dehiscence

Pφ **Wound dehiscence** is a disruption or a loss of continuity of a surgically closed layer of skin or fascia.

TP Wound tension, ischemia, poor nutrition, steroids, obesity, and infection are the most common risk factors.

Dx Wound dehiscence is a clinical diagnosis. A closed skin incision may open in dehiscence. A fascial closure may break down under a closed skin incision. Fascial dehiscence is recognized when pink "salmon" colored drainage leaks from the incision usually within the first two weeks days after abdominal surgery.

Tx Treatment depends on the patient's condition and timing of diagnosis. Early recognition in stable patients often warrants a return to the operating room to close the developing fascial defect. In cases of late recognition or unstable patients, the incision and defect may be left to heal by granulation provided evisceration of intra-abdominal contents is unlikely. **See Sabiston 15, Becker 9.**

Evisceration

Pφ **Evisceration** is a frank fascial disruption resulting in exposure of abdominal contents.

TP Risk factors are same as for dehiscence (see above).

Dx Visualization of abdominal contents within the wound confirms the diagnosis.

Tx Evisceration is a surgical emergency mandating immediate sterile closure of the abdominal wall defect. As an immediate temporary measure, the exposed organs should be covered with sterile warm saline dressings to prevent tissue dehydration. Use large laparotomy pads or sterile towels. When confronted with an evisceration or a wound dehiscence, discourage use of smaller sponges, which can ultimately be lost or overlooked. **See Sabiston 15, Becker 9.**

Enterocutaneous Fistula

Pφ **Enterocutaneous fistula** (ECF) is an abnormal communication between the bowel lumen and the skin, with drainage of bowel contents to the outside. These fistulas are characterized by the intestinal site communicating with the skin: gastrocutaneous (stomach), enterocutaneous (small intestine), or colocutaneous (large intestine) fistulas.

TP Enterocutaneous fistulas occur most commonly in patients with multiple abdominal injuries, multiple surgeries, or a "damage control" abdomen (skin and fascia left open to granulate because abdomen cannot be closed).

Dx Bowel contents and air bubbles draining into the wound make the clinical diagnosis. A fistula may be confirmed by CT scan with oral contrast, a small bowel series with contrast looking for extravasation of contrast into the wound, or a sinogram (a contrast study done through the exit point on the body wall).

Tx Treatment is usually nonoperative and consists of bowel rest, total parenteral nutrition (TPN), correction of electrolytes abnormalities, and acid suppression (histamine antagonists or proton pump inhibitors). Somatostatin analogs may be used to reduce GI and pancreatic secretions; however, there is no firm evidence that fistula closure is hastened. Nutritional support and local wound care are most important for fistula closure. Low output fistulas (<500 mL/day) will close over weeks to months provided there is no distal obstruction. A high output fistula that has not shown improvement for 6 months may necessitate surgical closure as a last resort. Factors that impede or prevent fistulas from closing are remembered by the mnemonic "FRIEND": **F**oreign body, **R**adiation, **I**nfection/Inflammation, **E**pithelialization, **N**eoplasm, **D**istal obstruction. **See Sabiston 15, 48.**

Necrotizing Fasciitis

Pφ **Necrotizing fasciitis,** which develops as a progressive, rapidly spreading, inflammatory infection, is a surgical emergency. This process occurs in the deep fascia with secondary necrosis of the subcutaneous tissues.

TP Wounds present with early and rapid spread of dusky, bluish-purple skin associated with subcutaneous emphysema and a pathognomonic foul smelling, gray serous fluid. Progression of tissue destruction and systemic sepsis can occur within hours and can become lethal if not treated immediately.

Dx Early recognition is imperative. The classic organisms responsible are ß-hemolytic streptococci, coagulase-negative staphylococci, or *Clostridium perfringens*. However, in many infections a polymicrobial profile will be cultured.

Tx Treatment is *emergent surgical debridement* of all nonviable tissue. Multiple subsequent debridements may be required. Tissue loss can be extensive. Broad spectrum antibiotics are initiated, and aggressive fluid resuscitation is mandatory. When necrotizing fasciitis presents in the male or female perineum, it is commonly referred to as Fournier's gangrene. **See Sabiston 14, Becker 10.**

ZEBRA ZONE

a. ***Ascitic leak*** may occur in patients with ascites related to cirrhosis, portal hypertension, or cancer who undergo abdominal surgery. When an operation is necessary in a patient with ascites, wound management is optimized by sealing the skin with a tight suture closure. Tx of ascites should be directed at the underlying pathology. **See Sabiston 12, 53.**

b. ***Pancreatic fistula*** is a complication following pancreatic surgery or trauma where pancreatic fluid leaks through the incision. Dx is confirmed by testing the fluid for amylase level. Tx includes proper wound care, TPN, bowel rest, and inhibition of GI secretion with somatostatin analogs. **See Sabiston 15, Becker 24.**

Practice-Based Learning and Improvement: Morbidity and Mortality Self-Assessment Form

Complication	Duodenal stump blow-out on POD #4
Surgery performed	Vagotomy and antrectomy for duodenal ulcer disease (Billroth II)
Type of complication	Technical error; probably preventable
Patient's disease	46-year-old man with "kissing ulcers"—a posterior duodenal ulcer and an anterior ulcer that presented with perforation

Presentation	Patient febrile (T = 102) beginning on POD #3; biliary contents noted in upper portion of midline wound on POD #4.
Intervention	HIDA scan demonstrating bile leak at duodenal stump. Reexploration and reclosure of duodenal stump with an omental patch. Tube duodenostomy (to decompress duodenal stump) brought out through lateral incision.
Outcome	Midline wound left open to granulate by secondary intention; patient recovered and was discharged home.
Risk factors	Duodenal stump blow-out is a known complication after a Billroth II procedure; when this surgery is performed for duodenal ulcer disease, the duodenum at the closure site may be somewhat inflamed.
How were risks addressed?	Jackson-Pratt drain was left at the duodenal stump.
What happened?	The duodenal stump broke down; bilious drainage leaked into the RUQ and tracked to the superior aspect of incision on POD #4.
What could have been done differently?	Given the risk factor above, a tube duodenostomy should probably have been placed at the initial procedure as a precaution.
Would outcome have been different?	A second operation under general anesthesia, an open wound, and prolonged hospitalization might have been avoided.

Interpersonal and Communication Skills

Setting Expectations

When a patient presents with a wound complication, it is worrisome for the patient and distressing to the surgeon. It is important to reassure the patient, explain the complication in understandable terms, and effectively communicate wound management with the nursing staff or caretakers. It is important to give the patient an honest and accurate expectation of the wound healing process and a generous estimate of complete healing time. When discussing any procedure with a patient *before* surgery, mention infection as a possible postoperative complication. By describing preoperatively what would be done to take care of a postoperative wound infection, patients are better prepared in the event that infection actually occurs.

Professionalism

Commitment to Honesty with Patients

Your angry patient has a wound infection and blames you for the outcome. How do you respond?

Be open and honest with the patient regarding what you believe to be the factors resulting in infection. Though it is appropriate to include the patient's inherent risk factors as part of the discussion, don't appear to be defensive, shifting blame to the patient. Try to emphasize what you will be doing to treat the infection and focus on the eventual positive outcome.

These are difficult issues that test the professionalism of all surgeons.

Systems-Based Practice

Preparing a Patient for Transfer to Long-Term Care or Other Facilities

Postoperative patients with wound complications or wound management needs require specific instructions for the patient and the nurse. In the event of a transfer to a nursing home or rehabilitation facility, make the appropriate phone calls to the new facility so that a proper transfer of care can be organized in a timely fashion. Be specific about the material and methods used (wet to dry gauze, packing, etc.). Always document the status of the wound at the time of discharge and include characteristics of size, depth, granulation, extent of undermining, and exudative status. Pictures or drawings can be very helpful to monitor the healing progress over time. For complicated patients or those with a vacuum-assisted wound closure system (wound V.A.C.), it is often appropriate to involve a fully trained wound specialist in the patient's care.

If you have had the opportunity to evaluate a patient with a postoperative problem, you are encouraged to review your patient's course in the context of the Competency Self-Assessment Form on page 35, which can also be found as a Word document on the book's Web site at www.studentconsult.com. How quickly did you and your team discover and respond to the problem? If appropriate, consider filling out a Morbidity and Mortality Self-Assessment Form by photocopying the form found on page 34 or by using the Word document on www.studentconsult.com.

Professor's Pearls: Postoperative Care

Section Review

Consider the following clinical problems and questions posed. Then refer to the professor's discussion of these issues.

1) A 65-year-old male underwent a left colectomy 5 days ago for colon cancer. Hi preoperative cardiac evaluation prior to surgery was unremarkable. On the morning of POD #5 he presents with sudden shortness of breath while getting out of bed.
VS: T = 99.8, P = 125, R = 26, BP = 130/80
Lung examination: clear bilaterally
ABG pH = 7.48, $P_{CO_2} = 30$, $Pa_{O_2} = 84$ on room air.
What is your differential dx and what measures would you undertake for dx and therapy?

2) A 70-year-old male with a past medical hx of benign prostatic hypertrophy is status-post lysis of adhesions for a small bowel obstruction. Now, on POD #4, he has a new complaint of lower abdominal pain. He also has had problems sleeping, but the multiple Benadryl PRN he's received for the past 3 nights have helped. You are called to the floor because he has had no urine output for the past 16 hours.
VS: T = 98.8, P = 92, R = 16, BP = 150/84
Physical examination reveals only suprapubic tenderness.
Stat CBC and BMP are within normal limits except a creatinine of 1.5 (baseline 1.0).
What diagnostic and therapeutic measures are in order?

3) A 24-year-old male is 4 days from a gunshot wound to the abdomen with multiple small bowel perforations. He has been persistently febrile since surgery. Breath sounds are diminished at both bases. You are called to see his midline incision because the nurse has spotted material that she believes to be feculent drainage from the superior part of the midline incision.
What is the differential dx? What are your initial diagnostic and therapeutic measures?

Discussion by Leo A. Gordon, MD, Cedars-Sinai Medical Center, Los Angeles, California

Answer 1
POD #5. Everything has gone smoothly and the team is probably thinking about advancing the patient's diet and preparing the patient for discharge. As with any surgical patient, the details of the

operative procedure must be reviewed. How low was the lesion? Were there technical problems with the anastomosis? Though the presentation is classic for a primary pulmonary event such as pulmonary embolus, the surgeon must always consider that this could be an anastomotic leak presenting as sepsis and shortness of breath.

Pulmonary and cardiac evaluations are required and transfer to an acute care setting is advisable. Assure adequate oxygenation and consider heparinization until a pulmonary embolus is r/o by spiral CT of the chest. If the cardiac and pulmonary evaluations are negative, the anastomotic site should be examined using a water-soluble contrast medium.

Answer 2

Always keep in mind that common things occur commonly. This 70-year-old male is known to have a large prostate. He undoubtedly received large volumes of fluid during his surgery 4 days prior. The *total absence* of a urine output (as opposed to a low urine output) speaks for urinary obstruction, most likely related to his prostate. A bedside bladder scan will prove the underlying problem. Pass a urinary catheter and the problem is solved.

But wait! You can't get past the prostate! Despite the lubricant, multiple penile angulations, twisting and other *cirque du soleil* tubular contortions, the catheter will not pass. If you have experience passing a coude tip catheter, this would be the next step. The most important point to be made here, however, is to avoid urethral trauma, which can create a larger problem than the one you are trying to solve. Hence, a STAT urology consult may be in order.

Answer 3

When asked to evaluate wound drainage, one must be conversant with the underlying procedure. In this case our patient had multiple small bowel perforations from a gunshot and was operated on urgently.

How were the perforations closed? Were there technical difficulties with the abdominal wall closure? Were stay sutures or retention sutures used?

Take a clean gauze pad and press it gently over the draining area and then examine the pad: is it a liquefying hematoma? Are enteric contents present? If the material looks enteric, one must assume that an enterocutaneous fistula has developed, most likely from one of the enterotomy closures. Initial tx is to make the patient NPO, observe the amount and nature of further drainage, and observe the patient closely for signs of sepsis (in the event that the leaking enterotomy is not completely drained to the outside).

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Chapter 47
Introduction to the Trauma Patient: Using the Primary and Secondary Surveys

Amy J. Goldberg MD

PRIMARY SURVEY: The ABCs of Trauma

AIRWAY, BREATHING, CIRCULATION, DISABILITY, EXPOSURE
All trauma patients are evaluated in a standardized systematic fashion. Upon initial presentation, a primary survey is performed. Abnormalities are treated as they are identified. After the primary survey has been completed and the patient is stabilized utilizing resuscitative procedures, a detailed secondary survey is undertaken.

AIRWAY: The quickest and easiest way to evaluate the airway is to talk to the patient. Briefly introduce yourself and ask the patient his or her name. A simple response by the patient tells you that the airway is patent and that the patient has adequate cerebral perfusion to respond appropriately.

The airway may be compromised due to direct injury to the mouth or trachea, presence of vomitus or a foreign body such as dentures, significant head trauma producing a decrease in mental status, or severe hypotension from a multitude of causes leading to decreased cerebral perfusion. If the airway is not patent or the patient cannot adequately protect his or her airway, the patient should undergo orotracheal intubation. If intubation is necessary, it is imperative that you provide cervical spine stabilization. To ensure proper placement of the endotracheal tube check for end-tidal CO_2 and listen for bilateral breath sounds. Rarely, a surgical airway by cricothyrotomy will be needed.

BREATHING: Examination of breathing requires the auscultation of both lung fields, determination of the position of the trachea (midline or deviated), and the presence of jugular venous distention (JVD). These physical findings may indicate the presence of a simple pneumothorax or hemothorax, tension pneumothorax, or cardiac tamponade, which must be identified and treated.

CIRCULATION: Circulation examination includes determining the patient's blood pressure and pulses (radial, femoral), applying direct pressure on any bleeding sites, sending blood for type and crossmatch, and placing large-bore IV lines in the antecubital fossa. Isotonic fluid, either lactated Ringer's or normal saline, is infused so that the fluid will stay in the intravascular space. If a peripheral line cannot be placed, a central line should be placed in either the jugular, subclavian, or femoral veins. If the patient's blood pressure is refractory to IV fluid, uncrossmatched blood should be transfused in the trauma bay.

DISABILITY: Examination of disability includes determining the size of the pupils and response to light and measuring the Glasgow Coma Scale (GCS) score. The GCS gives patients a score for best motor response (1–6), best verbal response (1–5), and eye opening (1–4). Best score is 15 and worst is 3.

EXPOSURE: The patient must be fully exposed and log rolled. All clothing must be removed, and the presence of gunshot wounds, stab wounds, fractures, abrasions, lacerations, and contusions are noted. Keep in mind that the patient may have been shot and then subsequently involved in a car crash.

As you proceed through the primary survey, don't move past the airway unless the airway is patent and the patient can protect his or her airway. If the patient is obtunded from head trauma, intubate the patient before moving on to breathing. If you notice that breath sounds are unequal, you should perform a chest tube or needle decompression of the thoracic cavity. You should not proceed to the secondary survey unless the primary survey and the resuscitation of all vital functions have been completed.

SECONDARY SURVEY

The secondary survey is a detailed head-to-toe evaluation of the patient. The examination begins with the evaluation of the head, eyes, ears, nose, and throat and proceeds to the neck, chest, abdomen, pelvis, genitalia, extremities, and back, and is completed with a detailed neurological examination. Touching the patient in a systematic fashion during this evaluation is critical to diagnosing injuries.

HEENT: scalp lacerations, pupil size, hemotympanum, crepitus to the bones of the face, blood or swelling in the mouth, rhinorrhea, Battle's sign, raccoon's eyes

NECK: position of trachea, presence of JVD, lacerations, hematoma, cervical spine tenderness, crepitus or subcutaneous air

CHEST: breath sounds, chest wall instability, crepitus, subcutaneous air, rib fractures

ABDOMEN: wounds, abrasions, tenderness, distention, seat belt sign; rectal examination—presence of blood or high-riding prostate

PELVIS: bony stability, suprapubic hematoma

GENITALIA: scrotal hematoma, vaginal laceration; blood at the urethral meatus; rectal examination—presence of blood or high-riding prostate

EXTREMITIES: bony deformities, crepitus, lacerations, distal pulses

BACK: abrasions, contusions, wounds, bony tenderness of the thoracic or lumbar spine, stepoffs, and swelling

NEUROLOGICAL EXAMINATION: complete motor and sensory examination

The history should focus on any information that can be obtained from the scene by the emergency medical personnel, the police, or the patient. A rapid review of past medical and past surgical histories, medications, allergies, social history, events surrounding the injury, and last meal should be obtained.

It is during the secondary survey that plain films of the neck, chest, and pelvis are obtained. **FAST** (focused abdominal sonography for trauma) examination is performed when appropriate. See Chapter 48, Trauma Radiology Tools, for more information.

Chapter 48
Trauma Radiology Tools

Jonathan R. Hiatt MD *and Michael Zucker* MD

The radiologic examination of the trauma victim provides important adjunctive information for early decision making and triage.
For most injuries due to blunt trauma, plain films of the cervical spine, chest, and pelvis are obtained and sonographic evaluation of the abdomen and pericardium is undertaken. CT is used for diagnosis of specific injuries in the head, neck, chest, abdomen, and pelvis. Arteriography is used for suspected bleeding in association with pelvic fractures and sometimes for definitive diagnosis of injuries to the thoracic aorta.

The following is a brief description of the radiographic studies used most commonly in initial trauma management. The key features specific to each of the studies are emphasized, as are the major findings that should be sought.

Cross-Table Lateral Cervical Spine Film

The film should be inspected for alignment, major fractures, and major distraction injuries. See Figures 48-1 and 48-2.

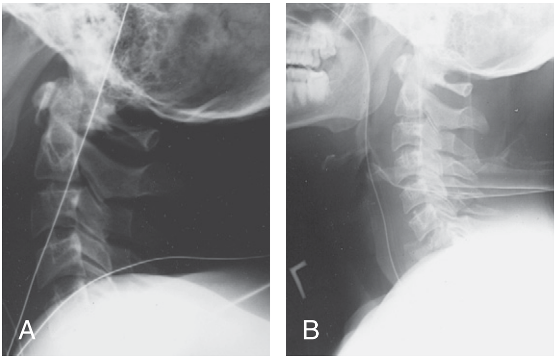

Figure 48-1 This pair of pictures demonstrates the inadequacy of a C-spine film when the C7 vertebra is not visualized (**A**). A repeat lateral x-ray shows a burst fracture of C7 (**B**).

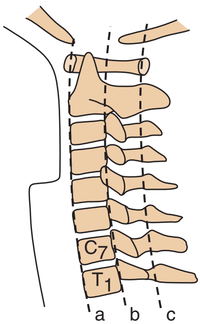

Figure 48-2 The lateral C-spine film should be inspected for alignment, major fractures, and major distraction injuries. Three lines should be drawn or imagined to assess alignment: a, anterior vertebral line; b, posterior vertebral line; c, spinolaminar line.

Look for loss of height of vertebral bodies or body fracture. Look for fractures in all bony parts, including pedicles, laminae, and spinous and transverse processes. Soft tissue swelling anterior to the anterior vertebral line is also a sign of spinal injury.

Anterior-Posterior Chest Film

The film should be inspected for injuries to bones, pleural spaces, lung parenchyma, and mediastinal structures. See Figures 48-3 to 48-5.

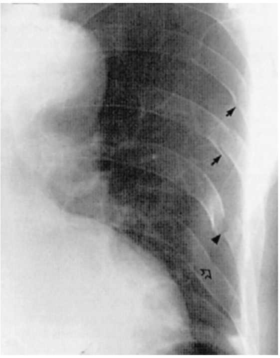

Figure 48-3 Fractures of ribs, clavicles, humeral heads, spinal column, and scapulae may occur. The film shows multiple rib fractures.

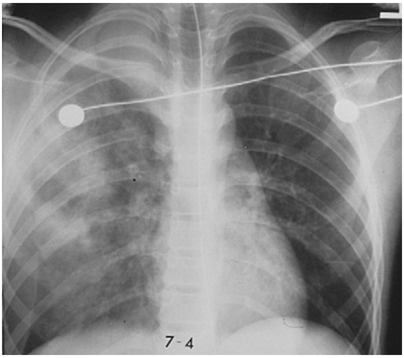

Figure 48-4 Pulmonary parenchymal injury. The right lung field shows a pulmonary contusion.

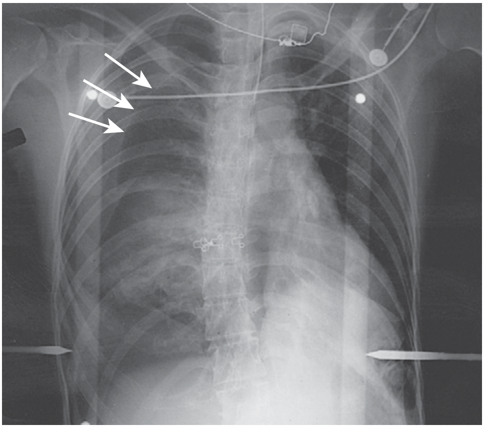

Figure 48-5 Pneumothorax (*arrows*)

In the pleural spaces, the major findings are pneumothorax (see Fig. 48-5) and hemothorax (Fig. 48-6). The diaphragmatic sulcus is an important window. A deep sulcus indicates pneumothorax, and a blurry sulcus indicates hemothorax.

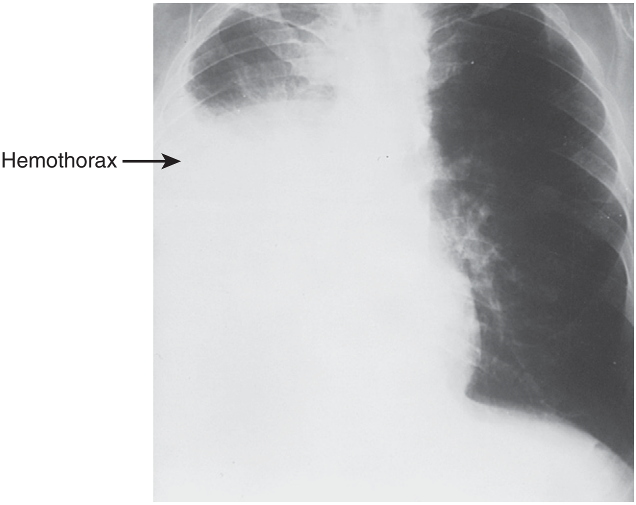

Figure 48-6 Hemothorax

Evaluating the Mediastinum

In the mediastinum, injuries may occur to the heart and great vessels. The cardiac silhouette is inspected for contour. The mediastinum is inspected and measured. Mediastinal widening (>8 cm) suggests thoracic aortic injury, which must be confirmed with a helical contrast-enhanced CT or formal thoracic arteriography. See Figure 48-7.

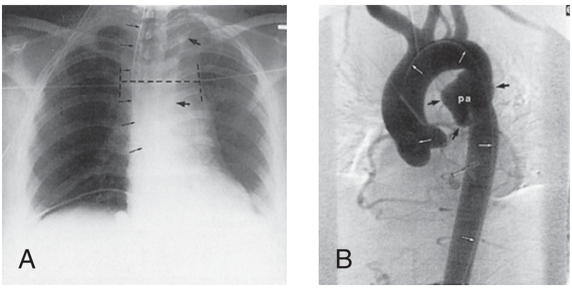

Figure 48-7 **A**, Mediastinal widening noted on plain CXR. **B**, Thoracic arteriography demonstrates aortic disruption (black arrows).

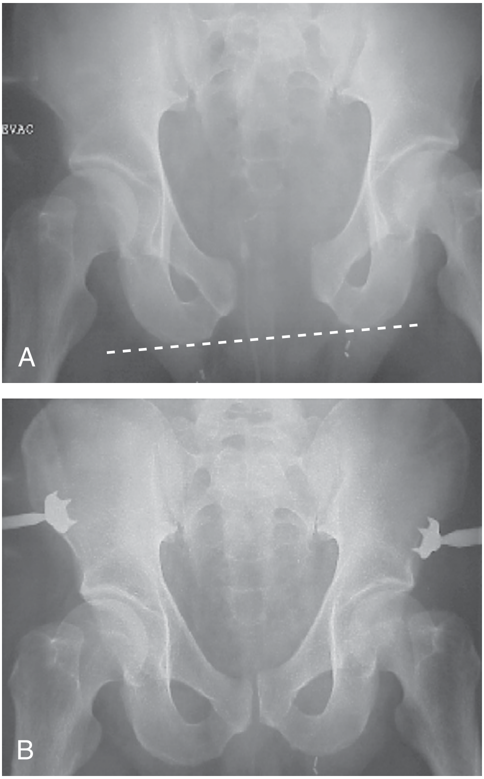

Figure 48-8 Disruption of the pubic symphysis and sacroiliac joint. **A**, Vertical shear produces elevation of the hemipelvis, demonstrated by the dashed line drawn under the ischial tuberosities that should be straight, rather than sloping. **B**, Placement of an external fixator closes the pelvic ring and helps control hemorrhage. Massive pelvic hemorrhage from this type of injury may require angiographic embolization for control.

Anterior-Posterior Pelvis Film

Mechanisms of pelvic injury include lateral compression, anterior-posterior compression, and vertical shear. Key features on the pelvic film include bony integrity of the ilium, ischium, and pubis, diastasis of the symphysis pubis (>1 cm), widening of sacroiliac joints (>5 mm), and elevation of the hemipelvis. See Figures 48-8 and 48-9.

Sonography

The focused assessment sonography in trauma (FAST) is now a standard part of the initial evaluation and a rapid method to screen for potential injuries in the chest and abdomen. FAST is used to identify the gross presence of blood in the pericardium, peritoneum, or pelvis and facilitates rapid triage of unstable patients to the OR for identification and control of the bleeding injuries. Areas inspected with FAST include the pericardium, hepatorenal space, splenorenal space, and the pelvic cul-de-sac. See Figures 48-9 and 48-10.

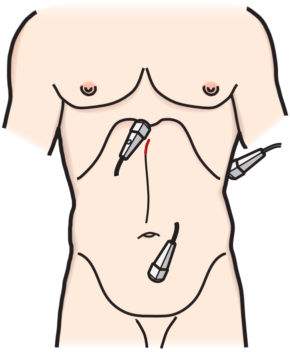

Figure 48-9 Placement of ultrasound probe for FAST.

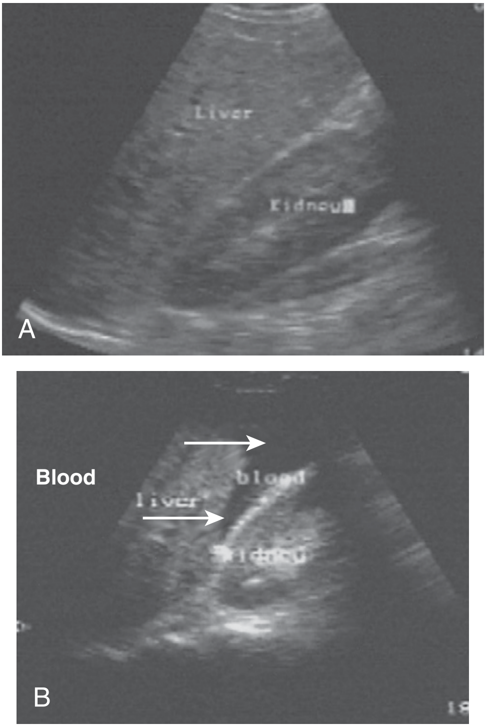

Figure 48-10 **A,** Normal saggital view of liver, kidney, and diaphragm. **B,** Same view, with blood in Morrison's pouch between liver and kidney.

Computed Tomography

CT is used for identification of blood, fluid, and specific organ injuries in hemodynamically stable patients. Unstable patients should never be taken to the scanner. IV contrast is used for chest and abdominal CT; the head CT is performed without contrast. See Figures 48-11 to 48-14.

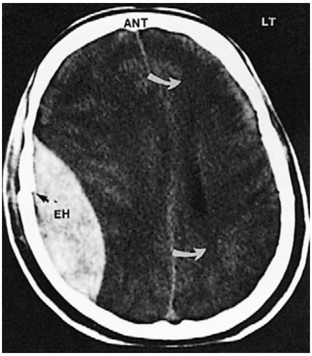

Figure 48-11 Right parietal epidural hematoma with midline shift (white arrows).

Figure 48-12 Left subdural hematoma with midline shift.

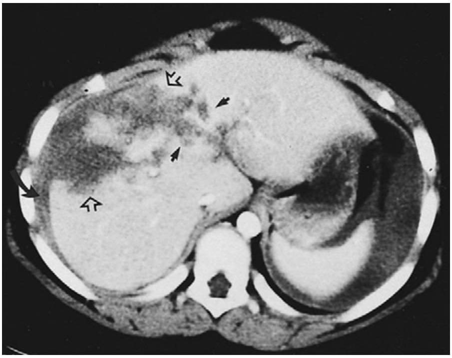

Figure 48-13 Abdominal CT shows a large liver laceration.

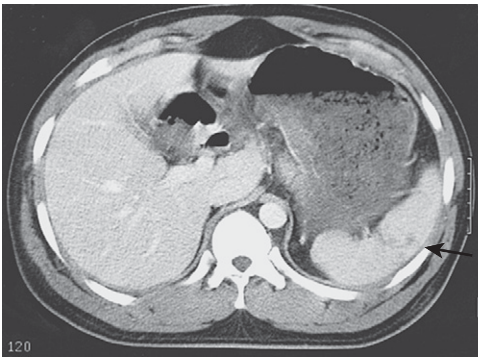

Figure 48-14 Splenic laceration following blunt trauma.

Chapter 49
Head Trauma (Case 32)

Michael W. Weaver MD and Darric E. Baty MD

Case: A 28-year-old male presents to the ED after a motor vehicle accident. He was an unrestrained driver with loss of consciousness. Upon arrival at the ED, he is belligerent, is not following commands, and has obvious facial/head trauma.

Differential Diagnosis

Skull fracture	Subarachnoid hemorrhage	Contusion
Epidural hematoma	Subdural hematoma	Diffuse axonal injury

Speaking Intelligently

When I encounter a trauma patient with a head injury, I first ensure that the ABCs have been adequately assessed and managed. A precise and thorough neurological examination is then performed during the secondary survey, noting Glasgow Coma Scale (GCS) score, pupil size and reaction to light, an extremity assessment, and a thorough motor/sensory examination. Once the patient is hemodynamically stable, a head CT should be performed. Patients who are alert and fully oriented generally do not require emergent neurosurgical intervention. Obvious head and facial trauma combined with agitation suggests a possible brain injury. The combination of the patient's neurological examination and the head CT help the neurosurgeon determine the best course of action, be it close neurological monitoring in the ICU, ventriculostomy, or an emergent trip to the OR.

PATIENT CARE

Clinical Thinking

- **Airway:** Ascertain whether or not the patient can protect his or her airway. Patients with severe neurological injury require intubation to prevent aspiration and hypoxia.

- **Breathing:** The breathing pattern is important: irregular respirations are part of Cushing's triad and denote brainstem compression. Intubation can be used to artificially raise the respiratory rate to lower the pCO_2; this is a short-term but effective method of lowering intracranial pressure.
- **Circulation:** Hypertension and bradycardia are the two remaining features of Cushing's triad that signal impending herniation and death. Hypotension must be avoided to prevent secondary brain injury.
- **Disability:** Cranial nerve function, GCS score, and extremity strength and sensation are important to assess.
- **Exposure:** Other significant injuries, including spinal fractures and scalp lacerations, may be easily overlooked if a full examination of the patient is not performed.

History

- What was the mechanism of injury? Was it a gunshot wound (large caliber vs. small caliber), an assault, a motor vehicle accident?
- Was there loss of consciousness? How long?
- What medications or drugs has the patient received or taken that might affect mental status?
- Does the patient have a previous neurological disorder or baseline impairment?
- **AMPLE** (**A**llergies; **M**edications; **P**ast medical hx; **L**ast meal; **E**vents leading to presentation)

Physical Examination

A Is the patient too lethargic to maintain an adequate airway?
B Is the respiratory rate regular and not too fast or too slow?
C Do the vital signs point to a missed source of bleeding, or is the patient herniating?
D Is the patient's neurological examination deteriorating? Are skull or facial fractures evident?
E Is there a large scalp laceration that requires washout and closure?

Tests for Consideration

- **CBC with automated differential:** Looking for adequate platelet count should neurosurgical intervention be necessary **$34**
- **PT/PTT/INR:** Looking for coagulation abnormalities that would require correction to stop bleeding and allow for neurosurgical intervention **$56**
- **Urine toxicology screen:** Looking for evidence of substances that might impair the neurological examination **$235**
- **Serum alcohol level:** Looking for an intoxicated patient who could be belligerent for reasons not directly related to neurological injury **$53**

IMAGING CONSIDERATIONS

→Head CT without contrast: Looking for hemorrhage and skull fractures, and the effect on the brain parenchyma $2,000

Clinical Entities — Medical Knowledge

Skull Fracture

Pφ A **skull fracture** is a break in the bones of the skull. Skull fractures typically bespeak head injury of significant force.

TP Skull fractures are usually associated with moderate to severe traumatic brain injury, although some patients may be awake and oriented.

Dx Clinical evidence of basilar skull fractures includes raccoon's eyes (ecchymosis around both eyes), Battle's sign (ecchymosis in the mastoid area), and cerebrospinal fluid (CSF) leaks through the nose (CSF rhinorrhea) or ears (CSF otorrhea). Head CT is usually the best test.

Tx Closed skull fractures do not generally require any surgical tx unless there is significant bony depression (greater than the adjacent inner table of the skull). CSF rhinorrhea or otorrhea can almost always be treated conservatively, but persistent leaks may require lumbar drainage or an epidural blood patch. Open skull fractures are usually washed out to prevent infection in patients who survive their injury. **See Sabiston 20, 72; Becker 11.**

Epidural Hematoma

Pφ An **epidural hematoma** is a collection of blood between the inner table of the skull and the dura mater. Epidural hematomas are usually caused by meningeal artery avulsions or tears, the most common being the middle meningeal artery.

TP Patients may present with the classic "lucid interval" between the time of the initial injury and the time when they quickly deteriorate secondary to an enlarging hematoma and impending herniation.

Dx Epidural hematomas are commonly associated with a skull fracture in the temporal bone near the middle meningeal artery, but they can occur elsewhere. They usually have an elliptical appearance on CT and do not cross suture lines (coronal or lambdoid sutures).

Tx Epidural hematomas usually require emergent neurosurgical evacuation, but small stable hemorrhages in an intact patient may be observed closely. **See Sabiston 20, 72; Becker 11, 47.**

Subarachnoid Hemorrhage

Pφ Trauma is the most common cause of **subarachnoid hemorrhage.** Ruptured cerebral aneurysm is another common cause of subarachnoid hemorrhage, and this possibility should be considered, based on the location of the blood.

TP Subarachnoid hemorrhage is most often associated with other brain injuries, such as skull fractures or contusions. It is usually seen near the convexity and in the sulci.

Dx The hemorrhage is visualized on head CT. A lumbar puncture is not indicated in the setting of head trauma.

Tx The management of traumatic subarachnoid hemorrhage is expectant. Serial neurologic examinations and follow-up head CT scans are usually sufficient to exclude and/or watch for associated injuries. **Sabiston 20, 72; Becker 47.**

Subdural Hematoma

Pφ A **subdural hematoma** is a hematoma that occurs in the space beneath the dura. It is caused by rupture of the bridging veins that pass from the surface of the brain to the dura, or by a cerebral contusion that has bled into the subdural space.

TP Subdurals are common in moderate and severe head injury; they can also be brought about by relatively minor trauma in the aging patient whose brain is atrophied and separated from the overlying skull and dural membranes.

Dx Acute and chronic subdural hematomas are easily detected on head CT scans. Subacute hemorrhages may be easily missed as they are isodense to brain. Regardless of age, the hematoma is crescent-shaped on head CT and will cross suture lines. Subdurals are commonly associated with significant underlying brain injury.

Tx Large, symptomatic subdurals are evacuated in the OR. Smaller hemorrhages must be followed as they tend to become chronic and may enlarge over time. **See Sabiston 20, 72; Becker 11.**

Contusion

Pφ A contusion is simply a "brain bruise." Just as bruises on the skin tend to look worse a few days after the injury, contusions can enlarge or appear on repeat head CT scans that were initially normal.

TP Contusions are often associated with other head injuries. Small contusions can be seen with relatively minor trauma, but large contusions typically imply a significant mechanism of injury.

Dx Contusions are diagnosed on head CT scans. They tend to appear on the surface of the brain, where the cerebrum has impacted the inner table of the skull; small contusions may be difficult to detect on CT scanners with lots of beam-hardening artifact.

Tx Most contusions can simply be followed with serial head CTs. Large, symptomatic contusions may require more aggressive intervention by a neurosurgeon. **See Sabiston 20, 72; Becker 11.**

Diffuse Axonal Injury

Pφ **Diffuse axonal injury** implies tearing of the axons in the brain secondary to a large shearing force.

TP The forces required to produce this type of brain insult typically result in severe traumatic brain injury. Patients may present in coma or with severely depressed mental status but without a significant brain mass that would explain their condition.

Dx The dx is largely clinical, with corroborating radiographic evidence. Small, punctate hemorrhages at the gray-white junction are sometimes seen.

Tx Depending on the patient's other neurological and radiographic injuries, a ventriculostomy may be required to monitor the intracranial pressure, which is often normal. Supportive care is provided as required by the patient's condition. **See Sabiston 20, 72; Becker 47.**

ZEBRA ZONE

Metabolic derangements: Whereas it may appear that a patient's change in mental status is related to head trauma, mental status abnormalities can also be associated with metabolic derangements, drug and alcohol intoxication, and underlying mental illness or prior neurological insult. It is important to consider that a nontraumatic etiology may underlie a change in mental status.

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
Guidelines for the Management of Severe Traumatic Brain Injury, 3rd edition

Authors
Bullock MR, Chestnut R, Clifton G, et al.

Reference
Journal of Neurotrauma 2007;24(suppl. 1).

Problem
Prior to the publication of the first edition of this paper (1996), there were few, if any, published guidelines for the tx of severe traumatic brain injury.

Intervention
None

Quality of evidence
Meta-analysis of best evidence

Outcome/effect
The publication of this paper allowed the distribution of a set of guidelines that helps neurosurgeons think about what measures are effective in head injury and where more research needs to be done.

Historical significance/comments
Although most of the guidelines do not have high-quality evidence supporting them, they provide national standards for care of patients with head injuries.

Interpersonal and Communication Skills

Delivering Bad News in Trauma
The news of neurologic injury and its associated morbidity and mortality are often devastating to patients and their families. A direct and honest but empathic approach will convey the urgency of the situation while helping establish a good patient-physician relationship that may become long term. Recognize that in the trauma situation (as opposed to dealing with a cancer dx), neither the patient nor the family has *any* preparation for receiving this news. Antcipate a wide range of emotional reactions from patients and family members. Patience, good listening, and empathy are the best interpersonal skills at this point.

Professionalism

Commitments to Just Distribution of Finite Resources and to Professional Responsibilities

Research has shown that universal helmet laws reduce deaths and serious injuries among motorcyclists. Reductions in helmet use resulting from weakening or repealing motorcycle helmet laws are consistently followed by significant increases in the numbers of injuries and deaths. A universal helmet law in Texas, for example, was estimated to have saved 650 lives between 1968 when it went into effect and 1977 when it was first amended. When the amended law covered only riders younger than 18, its enactment was followed by a 35% increase in motorcyclist fatalities. When Texas reinstated universal coverage in 1989, helmet use, which had dropped to 41% under the partial law, promptly rose to 98%, and serious injury crashes per registered motorcycle again decreased by 11%.

These are societal issues that require the input of medical professionals. Tracking patient outcomes leads to databases that, when appropriately analyzed and disseminated, serve as catalysts for societal change.

Systems-Based Practice

Standardization of Clinical Information: The Glasgow Coma Scale

The GCS is the most widely used scoring system for quantifying the level of consciousness in a patient following traumatic brain injury. This standardized method of evaluating patient status is relatively simple, has a high degree of interobserver reliability, and correlates with outcome following brain injury.

Glasgow Coma Scale

Eye Opening (E)	Verbal Response (V)	Motor Response (M)
4 = Spontaneous	5 = Normal conversation, fully oriented	6 = Follows commands
3 = To voice	4 = Disoriented conversation	5 = Localizes to pain
2 = To pain	3 = Words, but not appropriate	4 = Withdrawals to pain
1 = None	2 = No words, only sounds	3 = Decorticate posture
	1 = None	2 = Decerebrate posture
		1 = None
		Total = E + V + M

As indicated in the GCS, the observer notes the best eye opening response, the best verbal response, and the best motor response.

The patient's GCS score represents the sum of the individual scores for each of the categories. Endotracheal intubation (the patient cannot talk) is a limitation. In this instance the score should be followed by a "T," as in 10T. The GCS score may also be expressed by components (e.g., E4 M6 V5). An intubated patient would again be scored using the "T" designation in the verbal category (e.g., E4 M6 V1T = 11T).

Chapter 50
Penetrating Neck Injury (Case 33)

Abhijit S. Pathak MD and
Christine T. Trankiem MD

Case: A 44-year-old female presents to the ED with a stab wound to the left neck.

Differential Diagnosis

Carotid artery injury	Tracheal injury/laryngeal injury
Jugular vein injury	Esophageal injury

Speaking Intelligently

When I see a patient with a stab wound to the neck, I first check the ABCs and begin the resuscitation. My major concern is the airway. If there is any question as to whether the airway is compromised, I intubate the patient and provide cervical spine immobilization given the possibility of associated spinal injury. I make every attempt to document a neurological examination, including Glasgow Coma Scale (GCS) score, prior to intubation. Next, I assess for "hard signs" suggesting major vascular or aerodigestive tract injuries that would mandate immediate operation and neck exploration, such as active bleeding, expanding or pulsatile hematoma, hemiparesis, air bubbling from the wound, stridor, or hemodynamic instability. If the patient has no hard signs and is stable, I evaluate whether the platysma muscle has been violated, and if so I obtain the appropriate studies to evaluate for injury to vascular structures, the digestive tract, and the structures of the airway.

PATIENT CARE

Clinical Thinking

- Consider review of the primary and secondary surveys in Chapter 47, Introduction to the Trauma Patient: Using the Primary and Secondary Surveys.
- **Airway:** Assess whether the airway is patent and if the patient can protect his or her airway. If not, you must protect the airway by endotracheal intubation. C-spine injury must be considered and the C-spine protected until injury is definitely excluded.
- In a patient with a stab wound to the neck, early control of the airway is key. If there are doubts about whether the patient can protect his or her airway, intubate the patient.
- **Breathing:** Assess for breath sounds over each lung field. Assess for the presence of crepitus, subcutaneous emphysema, or air bubbling from the wound.
- **Circulation:** Place two large-bore IV lines in the antecubital fossa and begin fluid resuscitation with normal saline. Look for active bleeding or an expanding hematoma. Place direct pressure over any active bleeding sites. Assess the patient for hemodynamic instability (hypotension, tachycardia).
- **Disability:** Evaluate the pupils and calculate the GCS score. Make a note of any neurological deficits.
- **Exposure:** Remove all clothing and log roll the patient to inspect for additional wounds.
- Injury to a major venous structure in the neck can lead to death from air embolus. Cover all open wounds, apply pressure as necessary, and place the patient in the Trendelenberg position.
- When the platysma muscle has been violated, there is the potential for injury to underlying structures. Use the location of the injury (zone I, II, or III; Fig. 50-1) to guide your diagnostic workup.

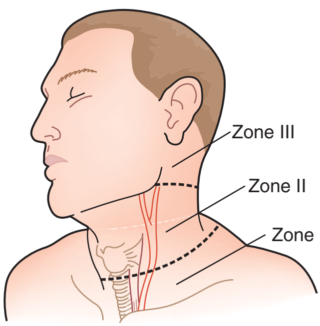

Figure 50-1 Neck zones

  - **Zone I: From the thoracic outlet as defined by the clavicles inferiorly to the cricoid cartilage superiorly.** Structures at risk: major vascular structures (great vessels, carotid and vertebral arteries, internal jugular veins), the apices of the lungs, esophagus, thoracic duct, and cervical nerve trunks.
  - **Zone II: From the cricoid cartilage inferiorly to the angle of the mandible superiorly.** Structures at risk: major vascular structures (carotid and vertebral arteries, jugular veins), the esophagus, and major airway structures (pharynx, trachea, larynx).
  - **Zone III: From the angle of the mandible inferiorly to the base of the skull superiorly.** Structures at risk: major vascular structures (internal carotid and vertebral arteries, jugular veins) and the pharynx.
- Classically, all patients with a zone II injury that violated the platysma underwent mandatory neck exploration; this led to many operations in which no injury was identified. Currently, patients with zone II injuries who are stable and have no hard definitive signs of underlying injury undergo further evaluation (CT angiography of the neck) and selective management based on the injuries identified. Zones I and III are bounded by bony structures, and injuries to these areas can be more difficult to access. Stable patients with an injury to zones I or III should undergo diagnostic studies (CT angiography of the neck) to identify injuries and provide a "road map" for the appropriate operative intervention.
- It is possible for injury to occur in more than one zone!

History

- With what was the patient stabbed? What was the trajectory of the stabbing?
- Is there a new neurological deficit?
- Shortness of breath? Hoarseness or change in voice? Hemoptysis? Pain or difficulty swallowing?
- **AMPLE** (**A**llergies; **M**edications; **P**ast medical hx; **L**ast meal; **E**vents leading to presentation)

Physical Examination

- **A** Airway patency? Can the patient protect his or her airway? Does the patient need a definitive airway/require intubation? Does the patient have an expanding hematoma compressing the trachea?
- **B** Check the respiratory rate and the oxygen saturation. Check for presence of subcutaneous emphysema or air bubbling from the wound? Is there a developing neck hematoma?
- **C** Check blood pressure, heart rate; is the patient hemodynamically stable or in shock? Are there signs of active bleeding or shock? Is there a bruit or hematoma?
- **D** Note the patient's GCS score and any neurological deficits.
- **E** Note specific location of stab wounds: zone I, II, III.

IMAGING CONSIDERATIONS

→**CXR (erect):** Evaluate pneumothorax, hemothorax, pneumomediastinum. $115

→**AP and lateral of the neck:** Evaluate subcutaneous air, foreign body, cervical spine injury. $250

→**CT angiography of the neck:** Ultra-fast spiral CT of the neck during rapid IV contrast bolus with 3D reconstructions. May not always be available. Catheter angiography remains the gold standard for vascular injury. $1,050

→**Barium swallow:** Evaluate the digestive tract for injury. Consider gastrograffin water-soluble contrast initially if suspicion for tear in the pharynx, esophagus. $265

Clinical Entities — Medical Knowledge

Carotid Artery Injury

Pφ An injury to the carotid artery can be partial (laceration) or complete (transection).

TP Clinical findings may include active arterial bleeding, expanding hematoma, a bruit, hemodynamic instability, or a new hemiparesis.

Dx Dx can be made clinically or by angiography (which could demonstrate extravasation of IV contrast or abrupt vessel cut-off).

Tx If the patient is neurologically intact, every effort should be made to repair the carotid artery. **See Sabiston 20, 67, 72; Becker 39.**

Jugular Vein Injury

Pφ An injury to the jugular vein can be partial (laceration) or complete (transection).

TP Clinical findings may include bleeding and hematoma.

Dx Dx is usually made at operation during neck exploration.

Tx The external jugular vein can be ligated without adverse effect. The internal jugular vein should be repaired if the patient's condition permits; otherwise, this structure can be ligated.

Injury to a major venous structure in the neck can lead to death from air embolus. Cover all open wounds, applying pressure as necessary.

Tracheal Injury/Laryngeal Injury	
Pφ	A tracheal injury or laryngeal injury is an injury to the airway.
TP	Clinical findings may include stridor, respiratory distress, crepitus, subcutanenous emphysema, air bubbling from the wound, or hemoptysis. Patients may report a change in voice, dysphagia, or odynophagia.
Dx	Dx can be made with visual diagnostic modalities such as direct laryngoscopy, tracheoscopy, or bronchoscopy.
Tx	A tracheal laceration can be repaired in one layer with an absorbable suture. If there is an injury to the esophagus or an artery in the vicinity, a flap of muscle or vascularized tissue should be interposed between the structures. If there is a complicated injury, a tracheostomy should be performed. Patients with a tracheal or laryngeal injury should remained intubated postoperatively for airway protection. **See Sabiston 20, 57; Becker 28.**

Esophageal Injury	
Pφ	The key to the patient with an esophageal injury is to identify the injury early; significant morbidity and mortality are associated with delayed dx and tx.
TP	Clinical findings may include air and saliva coming from the wound, dysphagia, odynophagia, and hematemesis.
Dx	Dx can be made with pharyngoscopy and esophagoscopy (with which a hematoma, bleeding, or laceration may be identified), and barium swallow (which may demonstrate extravasation of oral contrast).
Tx	An esophageal injury should be debrided and repaired in two layers. Placing a flap of muscle or vascularized tissue over the repair helps decrease the risk for fistula formation. Usually a closed-suction drain is placed near the repair. **See Sabiston 20, 41; Becker 27.**

Practice-Based Learning and Improvement: Morbidity and Mortality Self-Assessment Form	
Complication	Bleeding into neck on POD #1 after exploration for stab wound of neck
Type	Technical error; missed injury; preventable

Surgery performed	Left neck exploration for zone II injury
Patient's disease	25-year-old man stabbed in the neck
Presentation	8 hours after surgery, the patient began to have difficulty breathing, stridor, and swelling of his neck.
Intervention	Reexploration, identification, and ligation of bleeding vessel
Outcome	Complete recovery
Risk factors	Emergency surgery, with hematoma already present at exploration
How were risks addressed?	Hematoma was explored to better visualize ongoing bleeding.
What happened?	Hematoma obscured visualization; injury was missed.
What could have been done differently?	More meticulous dissection at first operation despite presence of hematoma. It is imperative to identify ongoing bleeding.
Would outcome have been different?	Second surgery and general anesthesia would not have been necessary.

Interpersonal and Communication Skills

Sorting Out Domestic Violence

Domestic violence refers to violence between spouses, cohabitants, and nonmarried intimate partners. It is perpetrated by, and on, both men and women, occurs in same-sex and opposite-sex relationships, and can be found in all cultures and social classes. Whether the traumatic episode is a stab wound to the neck or a more subtle trauma, you, as a physician, will often be the victim's first encounter for help. Sensitize yourself to watch for signals that a traumatic episode is the result of domestic violence—both in patients you have known for a long time and in isolated emergency department encounters. Develop a method with which you are comfortable inquiring if an episode of trauma is the result of "problems at home." When you suspect it, ensure that you connect your patient to the most appropriate resources for help.

Professionalism

Principle of Patient Autonomy
Each individual has the right to determine the extent of his or her own medical care. This can become problematic when a head-injured patient adamantly refuses potentially life-saving therapies. If a patient is not in possession of full mental capacities, the patient may no longer be able to make decisions for him- or herself. When emergency procedures are required, discussion with the family should determine what would be the patient's decision. If the family is not immediately available and the patient's condition mandates a quick decision, the most appropriate and conventional medical course of action should be pursued.

Systems-Based Practice

Business Skills: Collaborative Negotiation and Conflict Resolution
You are a senior member of Tri-County Trauma Surgeons and you are about to negotiate a new contract with the four hospitals covered by your group.

As a surgeon, your ability to negotiate collaboratively with hospital systems, other surgeons, patients, managed care companies, your spouse, and your children may be one of the most important skill sets that you will ever obtain. The skill and power of collaborative negotiation could be key to a successful outcome. In a study of a several hundred surgeons, the most common method of handling conflict was ***competition,*** closely followed by ***avoidance***; and the least utilized method of handling conflict was ***collaboration***. However, when queried about their goal, the participants' overwhelming response was about compromise. Here are some suggestions for collaborative negotiation techniques:

- Approach negotiation as an opportunity, not a chore. Avoid the tendency to psychologically withdraw from issues that are ambiguous and frustrating.
- Collaborate if possible, compromise if you must. The solution in most negotiations requires imagination and creativity. Find a way for the other party to get what they want at the lowest cost to you. This allows you to solve the problem while building relations and developing trust.
- Look beneath the surface. Remember the goal. Most successful negotiations rely on a mutual understanding of the interests of both parties.

Chapter 51
Penetrating Chest Injury (Case 34)

Amy J. Goldberg MD *and Justin B. Hurie* MD

Case: A 23-year-old male sustained a single stab wound to the left chest.

Differential Diagnosis

Simple pneumothorax	Tension pneumothorax	Hemothorax	Cardiac tamponade

Speaking Intelligently

When I see a patient with a stab wound to the left chest I check the ABCs and begin the resuscitation. My major concerns are the VS and hemodynamic stability. If the patient is stable, an upright CXR would be my first move. If left breath sounds are absent and there is hemodynamic compromise, I perform an immediate needle decompression, which is always followed by chest tube placement. Tachycardia and hypotension demand volume expansion. More than 1,500 mL of blood out the chest tube initially, or more than 200 mL/hr for 4 hours warrants a thoracotomy. If VS are lost, a stab wound to the left chest becomes an indication for ED thoracotomy.

PATIENT CARE

Clinical Thinking

- Consider review of the primary and secondary surveys in Chapter 47, Introduction to the Trauma Patient and Using the Primary and Secondary Surveys.
- Airway: Assess whether the airway is patent and if the patient can protect the airway.
- Breathing: Assess for breath sounds over each lung field and the presence of jugular venous distention (JVD) and/or tracheal deviation.
- Circulation: Place two large-bore IV lines in the antecubital fossa and begin fluid resuscitation with lactated Ringer's or normal saline. Place direct pressure over any active bleeding sites.
- Disability: Quickly evaluate the pupils and calculate the Glasgow Coma Scale (GCS) score.

- Exposure: Remove all clothing and log roll the patient to inspect for any additional wounds.

History

- What was the stabbing implement? What was the handedness of the assailant and the trajectory of the stabbing?
- What was the time of the stabbing?
- Shortness of breath? Chest or abdominal pain?
- **AMPLE** (**A**llergies; **M**edications; **P**ast medical hx; **L**ast meal; **E**vents leading to presentation)

Physical Examination

- **A** Airway patency?
- **B** Check the respiratory rate and the oxygen saturation.
- Trachea midline or deviation.
- Presence of JVD.
- Presence of breath sounds—are they equal?
- Crepitus, subcutaneous emphysema.
- **C** Blood pressure, heart rate; are there signs of active bleeding?
- **D GCS score; possible spinal injury.**
- **E** Note specific location of stab wounds, place markers on wounds.

IMAGING CONSIDERATIONS

➔**CXR (erect if possible):** Evaluate pneumothorax, hemothorax, pneumomediastinum. Note: in urgent settings these ideally should be clinical diagnoses rather than radiographic. **$120**

Clinical Entities — Medical Knowledge

(Simple) Pneumothorax

Pφ Simple pneumothorax is a collapsed lung secondary to a stab wound through the parietal and visceral pleura with accumulation of air within the pleural space.

TP Clinical findings will include the stab wound and decreased breath sounds on the affected side.

Dx Dx is made by CXR, provided hemodynamics are stable.

Tx Chest tube placement is appropriate tx. **See Sabiston 20, 57; Becker 11.**

Tension Pneumothorax	
Pφ	A **tension pneumothorax** is created when ongoing air leak allows continual ingress of air into the pleural space. This accumulation of air compresses the lung and mediastinal structures.
TP	Early findings include anxiety, dyspnea, tachypnea, tachycardia. Diminished breath sounds and hyperresonance of the chest wall on the affected side may be present. The typical patient will have hypoxia related to collapse of the ipsilateral lung and hypotension related to shifting of the mediastinum, which compromises venous return. The trachea may be deviated away from the side of the pneumothorax. JVD may be present.
Dx	Dx should be made by physical examination. Chest radiography should not be needed to identify a tension pneumothorax, and therapeutic intervention should not be delayed.
Tx	Immediate needle decompression of the chest with a 16-gauge angiocath in the second intercostal space, midclavicular line should be performed when a tension pneumothorax is suspected. Once accomplished, a chest tube is placed in a standard location. **See Sabiston 20, 57; Becker 11.**

Hemothorax	
Pφ	**Hemothorax** following a stab wound to the chest can be caused by bleeding from any structure in the thorax: the intercostal arteries, the lung, the great vessels, or the heart.
TP	Initial findings include anxiety, dyspnea, tachypnea, and tachycardia. Diminished breath sounds and dullness to percussion are found over the affected hemithorax. Massive hemothorax can produce significant hemodynamic instability secondary to hemorrhagic shock.
Dx/ Tx	When confronted with a stab wound and decreased breath sounds, place a chest tube. Findings of 1,500 mL of blood initially, or more than 200 mL/hour for 2 to 4 hours, generally mandate a thoracotomy to control bleeding. *Witnessed loss of vital signs in the ED is an indication for ED thoracotomy*. When encountering a hemothorax in either penetrating or blunt trauma, the possibility of a subdiaphragmatic injury must also be considered, as bleeding may have its origin from an intra-abdominal source. Focused assessment sonography in trauma (FAST) examination or CT of the abdomen/pelvis may aid in dx. **See Sabiston 20, 57; Becker 11.**

Cardiac Tamponade

Pφ/TP The pericardium is a two-layered membrane surrounding the heart that normally contains 20 to 50 mL of fluid. Rapid accumulation of as little as 150 mL of fluid after trauma can produce cardiac tamponade and hypotension. Traumatic sources of intrapericardial blood include chamber rupture, usually right-sided, because of the anterior orientation, or coronary artery laceration. The accumulation of fluid in the pericardial space increases the stiffness of the ventricle, and higher filling pressures are required to sustain cardiac output. With further fluid accumulation, increasing pericardial pressures cause reduction in systemic venous return, diastolic filling, and cardiac output. If untreated, cardiac tamponade can produce cardiovascular collapse and death. Beck's triad (arterial hypotension, venous hypertension, and muffled heart tones) is the classic presentation of tamponade. Narrowing of pulse pressures and *pulsus paradoxus*, a change of greater than 10 mmHg in the systolic pressure between inspiration and expiration, may also be seen. Patients with acute tamponade may present with dyspnea, tachycardia, and tachypnea.

Dx Dx is made by vital signs and by physical examination. FAST examination may reveal pericardial fluid. Echocardiography may used in stable patients. A surgical pericardial window may be required for diagnosis.

Tx Cardiac tamponade from penetrating injury is treated with immediate operative exploration and repair of the source of bleeding. Fluid resuscitation is needed to maintain preload and sustain cardiac output during transport to the OR. Subxiphoid percutaneous pericardiocentesis may be required as a temporizing measure. **See Sabiston 5, Becker 11.**

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
Timing of urgent thoracotomy for hemorrhage after trauma

Authors
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Institution
Multi-institutional study

Reference
Archives of Surgery 2001;136(5):513–518

Problem
What volume of thoracic hemorrhage due to chest trauma is associated with increased mortality and requires a thoracotomy?

Intervention
Exploratory thoracotomy after blunt ($n = 36$) or penetrating ($n = 121$) chest injuries

Evidence
Retrospective case series of 157 patients

Outcome/effect
The risk for death at blood loss of 1,500 mL was three times greater than at 500 mL and increased linearly with total chest hemorrhage after thoracic injury. This suggested that initial blood loss of 1,500 mL or ongoing hemorrhage is an indication for thoracotomy.

Historical significance/comments
Although retrospective, this multicenter study underscores important principles in the management of traumatic thoracic bleeding.

Interpersonal and Communication Skills

Empathy, Explanations, and Face-to-Face Hand-offs
Empathy is essential when dealing with a patient in need of a chest tube. It is important to remember that a chest tube in an awake trauma patient can be very painful. If possible, the procedure should be explained fully, consent should be obtained, and the patient should be reassured that all attempts will be made to minimize discomfort.

One of the most important communication skills required is to initiate a clear, comprehensive face-to-face transfer of patient information to the colleague who will assume care of the patient while you are out of the hospital.

Professionalism

Commitment to Professional Responsibilities
Trauma resuscitations are always stressful for all participants. The trauma team leader must maintain composure and communicate the plan of care clearly to the staff. Demonstrating strong leadership is not mutually exclusive with respecting the knowledge and perspective of the other health-care professionals on the team. In order to maximize the comfort zone for others to provide you the necessary continued informational flow about the patient’s condition, you must be respectful in your verbal and nonverbal communication. The successful trauma leader is confident and approachable.

Systems-Based Practice

Standardization of Supplies
The standardization and availability of supplies is critical to the provision of care in the trauma bay. When placing chest tubes for trauma, for example, it is essential that a large chest tube (#36 French) be placed. Directed posteriorly and superiorly, this large-diameter tube will stay patent in the presence of blood and also will remove air that is usually present. The readiness of appropriate supplies should be routinely reviewed periodically with nursing and hospital staff.

Chapter 52
Blunt Chest Trauma (Case 35)

Jeffry L. Kashuk MD *and Benjamin J. Rogoway* MD

Case: A 67-year-old male appeared to sustain blunt trauma to the chest in a head-on collision.

Differential Diagnosis

Editor's note: The previous chapter reviews penetrating chest trauma. Four clinical entities that comprise the differential dx for penetrating chest trauma are again considered in the differential dx for blunt trauma. Review the following clinical entities in the previous chapter:

Simple pneumothorax	Tension pneumothorax	Hemothorax	Cardiac tamponade

Now consider these additional problems specific to the differential dx of blunt chest trauma:				
Chest wall fractures: Ribs Sternum Clavicle	Open pneumothorax (sucking chest wound)	Airway obstruction (tracheal/ bronchial tree disruption)	Flail chest with underlying pulmonary contusion	Traumatic aortic disruption

Speaking Intelligently

The most common injuries to the chest wall—fractures of the ribs, sternum, and clavicle—are rarely life threatening, but they may portend more significant underlying visceral or neurovascular injury. I focus on six entities that are immediately life threatening:

1. Airway obstruction
2. Tension pneumothorax
3. Open pneumothorax
4. Flail chest with underlying pulmonary contusion
5. Hemothorax
6. Cardiac tamponade

The primary survey (ABCs) of the ATLS algorithm will direct me to evaluate for these six conditions first; only after assessment of hemodynamic stability and stabilization of airway, breathing, and circulation do I proceed to the secondary survey (complete head-to-toe physical examination), which includes a neurological examination to rule out spinal injury.

Chest radiography assists in the dx of pneumothorax, hemothorax, chest wall injuries, or pulmonary contusions. ***Focused assessment sonography in trauma (FAST) examination*** will rule out cardiac tamponade and will assist in the dx of associated abdominal injury.

Once primary and secondary surveys are completed, I usually obtain ***chest, abdominal, and pelvic CT scans*** in stable patients. Unstable patients may need urgent operative intervention, but ED thoracotomy in blunt trauma is virtually never successful.

PATIENT CARE

Clinical Thinking

- **Airway:** Along with standard airway assessment for patency and protection, one must carefully look for tracheal injury. Is there an obstruction or injury due to blunt disruption? Are there associated facial or neck injuries that would preclude endotracheal intubation and might indicate the need for a surgical airway?
- **Breathing:** Assess for breath sounds. If the airway is intact and breath sounds are absent, does the patient need immediate needle decompression or chest tube to treat a tension pneumothorax? This decision should be made on auscultation examination alone rather than waiting for an x-ray if the patient is unstable. Does the patient have a flail segment or sucking chest wound that needs coverage?
- **Circulation:** After large-bore IVs are placed and resuscitation initiated, is the patient still in shock? Have all body areas been examined for bleeding sites?

- **Disability:** Perform a neurological examination, assess the Glasgow Coma Scale score, and evaluate rectal tone.
- **Exposure:** After all clothing is removed, evaluate for additional wounds, fractures, or deformities that could account for blood loss.

History

- What was the mechanism of injury?
- If a motor vehicle collision, what details can be obtained from paramedics? VS in the field and en route?
- Patient's complaints; localization of pain?
- **AMPLE** (**A**llergies; **M**edications; **P**ast medical hx; **L**ast meal; **E**vents leading to presentation)

Physical Examination

- Head-to-toe physical examination (secondary survey).
- Evaluate and reevaluate the VS and pulse oximetry. Look for JVD and observe chest wall motion, flail segments, or sucking wounds. Check for pulsus paradoxus.
- Interrupt the physical examination if a life-saving procedure such as airway or chest tube placement is needed.
- Evaluate and reevaluate areas of ongoing blood loss, including open wounds and fractures. Are there associated abdominal, pelvic, or extremity injuries that could account for blood loss?

Tests for Consideration

- Routine trauma labs:
  - **CBC:** Helps gauge blood loss. **$36**
  - **Chem panel:** Monitors electrolyte status, which can help to prevent life-threatening abnormalities. **$120**
  - **ABG:** Measures oxygenation, ventilation, and acid-base status, and can help guide therapeutic decisions such as the need for endotracheal intubation or fluid resuscitation. **$100**
  - **Blood type and crossmatch:** Essential when transfusion may be needed. **$60**
  - **Coags–PT/PTT/INR, fibrinogens, and split products:** Needed for patients with ongoing hemorrhage and receiving massive transfusions. **$156**
- **Troponin levels:** Cardiac-specific marker for injury. May indicate cardiac contusion or concomitant acute myocardial infarction. **$115**
- **EKG:** Diagnoses new cardiac injury or uncovers chronic medical conditions that may affect treatment. **$150**
- **Transesophageal echocardiography (TEE):** Complementary examination for workup of possible blunt rupture of the thoracic aorta. May also be used to evaluate myocardial function. Test is operator dependent and invasive. **$1,000**

- **Esophagoscopy and/or esophagography:** Not for acute/unstable patients. Can identify otherwise occult esophageal injuries. $500
- **Bronchoscopy:** Not for acute/unstable patients. Can identify otherwise occult tracheobronchial tree disruption, especially in patients with persistent and/or massive air leaks. May also be useful therapeutically in the critical care setting. $353

IMAGING CONSIDERATIONS

➔**CXR:** Evaluate for pneumothorax, tension pneumothorax, hemothorax, chest wall fractures, and pulmonary contusions. $120

➔**FAST examination:** Evaluate for cardiac tamponade. $250

➔***CT of chest, abdomen, and pelvis* (for stable patients only):** Perform with IV contrast. Rapid, reliable imaging of lacerations and contusions. $1,150

➔**CT angiography:** Can be performed at the same time as routine CT on many high-speed spiral scanners. $800

➔**Catheter angiography:** Remains the gold standard for evaluation of aortic injury. $1,050

Clinical Entities — Medical Knowledge

Chest Wall Fractures

Pφ With excessive energy transfer during blunt trauma, any of the thoracic bones may potentially fracture—ribs, sternum, clavicle, or scapula. Simple rib fractures are the most common injuries and, although rarely life threatening, may be indicators of more significant underlying injury.

TP Patients usually report pain and tenderness over the fractured area and discomfort with deep breathing. Physical examination shows local tenderness, swelling, or ecchymosis around the fracture. A palpable defect or fracture-related crepitus may be present. Respiratory insufficiency may be seen in more severe cases and can be identified by observing for tachypnea, use of accessory muscles, and cyanosis. Anxiety and agitation are common.

Dx AP chest films are used routinely in the initial assessment. CT of the chest may provide more specific information regarding location and extent of specific injury.

Tx Pain control and observation are standard therapy for patients with simple chest wall fractures. Analgesic agents, intercostal nerve blocks, and epidural analgesia all have been used successfully. Aggressive pulmonary toilet is used to prevent atelectasis and subsequent pneumonia. Operation is rarely needed for simple fractures but may be required for significant comminution, hemorrhage from fractures that lacerate vessels, or chronic nonunion. **See Sabiston 20, 57.**

Airway Obstruction (Tracheal/Bronchial Tree Disruption)

Pφ Rapid deceleration or severe compression applied directly to the tracheobronchial tree are the usual causes of tracheobronchial disruption. The viscera are crushed between the anterior chest wall and the posterior vertebrae. Most patients with severe tracheobronchial injuries die from airway obstruction or associated injuries before reaching the hospital.

TP Respiratory distress is the most notable finding in these patients, who are stridorous and unable to phonate. If a chest tube has been placed, there is usually a massive air leak. Pneumothorax and subcutaneous emphysema are almost universally present.

Dx If the patient survives the initial assessment, CXR and/or CT will usually identify this major injury. Bronchoscopy may be required in the subacute setting to evaluate less pronounced injury. Laboratory studies are rarely useful.

Tx Surgical tx is required since blunt tracheal injuries are immediately life threatening and will not heal without repair. If the airway is compromised, endotracheal intubation should be performed. Flexible bronchoscopy may permit the tube to be guided distal to the site of injury. An emergent surgical airway may be needed if conventional endotracheal tube placement fails. Operative repair includes debridement of the fracture site and restoration of airway continuity. **See Sabiston 20.**

Open Pneumothorax (Sucking Chest Wound)

Pφ Though more common with penetrating mechanisms, open pneumothoraces may occur with blunt thoracic trauma. The pathophysiology is similar to that of a tension pneumothorax; however, the chest wall is compromised, and the pleural cavity is in communication with the atmosphere. Since the negative intrathoracic pressure is lost, all dynamic lung mechanics are affected. Intrathoracic pressures rise and can shift mediastinal components to the opposite side, with diminished cardiac output, hemodynamic instability and ultimate cardiovascular decompensation.

TP Patients typically present with respiratory distress due to collapse of the lung on the affected side. Physical examination should reveal an obvious chest wall defect. Auscultation reveals complete or near-complete loss of breath sounds.

Dx Dx is made by physical examination.

Tx Sucking chest wound is treated by placing a three-way occlusive dressing over the wound to allow outflow of air with exhalation while preventing continued inflow of air with inhalation. The intent is to prevent the rise of intrathoracic pressures in the affected hemithorax. A chest tube is then placed. After initial stabilization, most patients undergo operation for definitive chest wall closure. Prosthetic devices may be required to cover large defects. Pain control and pulmonary toilet are essential. **See Sabiston 20.**

Flail Chest with Pulmonary Contusion

Pφ By definition, flail chest is an injury that involves three or more consecutive rib fractures in two or more locations, producing a comminuted fracture with a free-floating, unstable bony segment that is detached from the remainder of the chest wall. As the injury requires a significant amount of force, associated injuries are common and should be aggressively sought. Pulmonary contusion is the most common local disturbance in association with flail segment. Mortality is significant.

TP Respiratory distress is the most common initial presentation. Dyspnea, tachycardia, tachypnea, pain, and tenderness usually are present. The flail segment often moves in a paradoxical motion, opposite to that of the remainder of the hemithorax. Respirations may be labored due to the increased work of breathing induced by the paradoxical motion of the flail segment. As the acute condition progresses, pulmonary function worsens. Auscultation virtually always demonstrates decreased breath sounds over the affected area.

Dx Dx is made by physical examination and CXR. CT may help in identification of early pulmonary contusion. Hypoxemia may be present and should be assessed with oximetry and blood gas analyses.

Tx The tx modalities described for patients with chest wall fractures are appropriate for flail chest. Pain control, pulmonary toilet, and supplemental oxygen are the primary therapies for pulmonary contusions. The severity of flail injuries and associated contusions frequently require endotracheal intubation and positive pressure mechanical ventilation. Patients may require sedation and neuromuscular blockade to overcome the work of breathing produced by the flail segment. Optimal ventilatory management is crucial, as these patients often progress to adult respiratory distress syndrome. IV fluids are administered judiciously because fluid overloading can precipitate respiratory failure, especially in patients with significant pulmonary contusions. **See Sabiston 20.**

Traumatic Rupture of the Aorta

Pφ/TP Traumatic rupture of the aorta should be suspected in any patient sustaining blunt chest trauma in association with deceleration injury. Aortic injuries cause or contribute to nearly 15% of deaths in motor vehicle accidents. Although the proximal descending aorta is most commonly involved at the ligamentum arteriosum where it is fixed, other areas may be involved as well, probably by mechanisms such as compression between bony fragments or temporary brief intraluminal hypertension. Physical findings may include intrascapular murmur, upper extremity hypertension, and unequal blood pressure or pulses in the extremities. Findings on CXR include mediastinal widening greater than 8 cm, obliteration of the aortic knob, depression of the left main-stem bronchus, apical pleural cap, or simply "a funny looking mediastinum." It should be emphasized that in the face of significant mechanism of injury and other associated trauma, a normal CXR does not r/o the injury.

Dx CT, CT angiography, MRI, and TEE are all variants of *screening* modalities and will show a mediastinal hematoma. These tests have not been validated for areas of the thoracic aorta other than the proximal descending portion. ***Due to artifacts and the potential for false-positive diagnoses, aortography remains the gold standard for dx, although continuing improvements in CT imaging suggest that this standard may be changing.*** In a patient with an obvious mediastinal hematoma on CXR, aortography should be performed. In a patient with a suspicious mechanism and normal CXR, CT may be performed to look for a mediastinal hematoma. If present, aortography is still required.

Tx Hemodynamically unstable patients with a dx established by aortography require prompt surgical attention if attempts at resuscitation have not stabilized VS. In stable patients, permissive hypovolemia and aggressive minimization of the dP/dT (concepts learned from the tx of aortic dissection and aneurysm rupture) are important principles of care. In selected patients, stent grafting of aortic tears may be preferred over open surgical repair (although long-term results are lacking). **See Sabiston 20, 67.**

ZEBRA ZONE

a. **Traumatic rupture of the diaphragm:** Rupture of the diaphragm is not a zebra, but is more commonly associated with blunt trauma of the abdomen, covered in Chapter 54. **See Sabiston 20.**

b. **Abdominal injury with hemoperitoneum:** Abdominal injury with hemoperitoneum is not a zebra; however, when considering blunt trauma to the chest, blunt trauma to the abdomen must also be considered. These entities are covered in detail in Chapter 54. **See Sabiston 20, 45; Becker 11.**

c. **Blunt injuries to the heart and great vessels:** Patients with significant blunt injuries to the heart and great vessel injuries almost never survive long enough to arrive at the hospital. ED thoracotomy is rarely indicated in these cases. **See Sabiston 20.**

d. **Esophageal rupture:** Esophageal injuries are rarely isolated in blunt trauma. Most such rare injuries will be discovered in association with other injuries on total body CT. **See Sabiston 20, 41.**

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
Selective management of flail chest and pulmonary contusion

Authors
Richardson JD, Adams L, Flint LM

Reference
Annals of Surgery 1982;196(4):481–487

Problem
Can flail chest and pulmonary contusion be managed safely with selective intubation and mechanical ventilation?

Intervention
The selective use of endotracheal intubation and mechanical ventilation was used in conjunction with fluid restriction, vigorous pulmonary toilet, and pain control.

Quality of evidence
Prospective nonrandomized study of 427 patients with severe blunt chest trauma

Outcome/effect

Selective intubation was used in 327 (77%) of patients (50% for flail chest only and 80% with pulmonary contusion only), of whom 96.6% were treated successfully. This study demonstrated the safety of selective intubation and showed that the incidence of complications of mechanical ventilation can be significantly reduced.

Historical significance/comments

A significant paradigm shift in the management of chest injuries occurred when it was recognized that the dx and management of the underlying pulmonary contusion was the most important predictor in outcome of blunt chest injury. It also showed that traditional tx (mechanical ventilation) may actually have been the cause of some of the complications (e.g., pneumonia).

Interpersonal and Communication Skills

Communicating with the Family about Past Medical History

Elderly trauma patients sustaining blunt multisystem trauma often have associated comorbidities such as cardiac and pulmonary diseases and long medication lists. The past medical hx requires careful attention to detail and close communication with the patient or family members if the patient cannot give the information. For example, elderly patients may be on anticoagulants, which would be a critical aspect of the hx. Careful attention to detail can be life saving.

Professionalism

Principle of Primacy of Patient Welfare; Commitment to Maintaining Appropriate Relations with Patients

Knowledge of a loved one's involvement in a trauma situation comes as a shock to the family. As trauma leader, you will be preoccupied with the trauma resuscitation and the patient's welfare. An ED liaison or another designee should be assigned to communicate with family members as they arrive on the scene. As soon as patient stability permits, directly acknowledge and support the needs of the patient's family.

Systems-Based Practice

Working with the Prehospital Team

An important feature of successful trauma care is the systematization of prehospital care. Paramedics, firefighters, and law enforcement officials are an integral part of the trauma care team.

When the patient arrives, all efforts should be made to take an accurate hx from those in the field: What were the VS at the scene and en route? Was there a prolonged extrication time? What lines have been placed and how much fluid was given? What VS have been monitored? Was there evidence of significant blood loss at the scene?

Law enforcement officials also have the responsibility for legal investigations, including drug and alcohol information. While patient care always takes priority, these officials must be allowed the opportunity to obtain the information they require and to follow their systems-based procedural protocols after the patient is stabilized.

Chapter 53
Penetrating Abdominal Injury (Case 36)

Mark J. Seamon MD and Brian P. Smith MD

Case: A 51-year-old male sustains a gunshot wound to the LUQ of the abdomen.

Differential Diagnosis

Hemoperitoneum from major vascular injury or solid organ injury.	**Peritonitis** from hollow viscus injury with peritoneal contamination.	**Retroperitoneal hematoma**

Speaking Intelligently

When I encounter a patient with penetrating abdominal trauma, I think of two things: First, does this patient have intra- or extraperitoneal bleeding that requires surgical intervention? Second, does the patient have peritoneal contamination requiring washout and repair of a hollow viscus? While there are subtleties of management depending on the mechanism of penetration, the underlying principle is that penetrating injuries with any hemodynamic instability and/or signs of intraperitoneal injury are treated operatively at the outset of management.

PATIENT CARE

Clinical Thinking

As for any trauma patient:

- **A** Does this patient have an adequate airway and the ability to protect it?
- **B** Is the patient breathing? Is oxygenation and ventilation adequate? Remember, a gunshot wound high in the abdomen may penetrate the diaphragm and cause a significant thoracic injury.
- **C** Does the patient have adequate blood volume and perfusion? How does the patient respond to resuscitation? Does this 51-year-old male take medications such as beta-blockers that might mask an appropriate tachycardia?
- **D** Evaluate the patient's ability to follow commands and respond appropriately. Is neurological disability a central phenomenon from shock, or is there a direct spinal cord injury?
- **E** The patient must always be adequately exposed to evaluate all injuries. Don't overlook the axilla, back, gluteal cleft, and perineum.
- Patients with penetrating abdominal injuries are best served by antibiotic therapy prior to operative intervention. Initial therapy should be broad, with coverage of both gram-positive and gram-negative organisms. Current practice guidelines advise broad-spectrum antibiotics prior to incision and throughout operation.
- Tetanus toxoid upon admission
- The care of the trauma patient does not end with intraoperative repair of injuries. The hypothermic, coagulopathic laparotomy patient is prone to numerous postoperative complications:
  - Expect to encounter significant ***postoperative hypovolemia***, often requiring massive volume resuscitation.
  - Anticipate (life-threatening) ***abdominal compartment syndrome***: look for a decrease in urinary output, increasing airway pressures, decreased venous return, and increasing abdominal pressure.

History

- Ascertain mechanism of the injury: the damage inflicted by a low-velocity handgun is far different from the cavitating blast effect exerted by a high-velocity hunting projectile.
- **AMPLE** (**A**llergies; **M**edications; **P**ast medical hx; **L**ast meal; **E**vents leading to presentation)
- Past medical hx provided by the patient or family may provide insight to observed physiology: for example, beta-blockade may mask the tachycardia of stage II shock.

Physical Examination

Editor's note: Though there may be exceptions, A GUNSHOT WOUND TO THE ABDOMEN GETS EXPLORED; END OF STORY. Keep this in mind as subtleties of the physical examination are discussed.

- Pay careful attention to the obvious signs of abdominal penetration and try to reconstruct the path of injury.
- Be skeptical of *apparent* injuries. Two holes aligned on a patient do not necessarily indicate entrance and exit wounds.
- Does the patient have abdominal pain? Is the patient tachycardic and hypotensive because of peritoneal hemorrhage? Are respirations labored because of a distended abdomen and limitation to diaphragmatic excursions or because of a missed pneumothorax?
- Check the NG tube after insertion: bloody nasogastric effluent?
- Rectal examination may reveal blood within the bowel lumen.
- Is the Foley catheter draining blood-tinged urine?
- Whereas all of these findings may corroborate the need for laparotomy, hemodynamic instability, distention, and peritoneal signs are nearly absolute indications for operative exploration.

Tests for Consideration

- **Blood typing and screening:** Assume that all patients will require operative intervention. **$65**
- **Obtain uncrossmatched blood,** if clinically indicated. **$440/unit**
- **CBC, basic metabolic profiles, and coagulopathy parameters** are generally standard, although the yield from these tests is often low. **$120**
- **Urine hCG** should be checked in women of child-bearing age, as the management of a pregnant woman might differ greatly from that of a nonpregnant woman. **$56**
- **Serum amylase** might indicate injury to a hollow viscus but, like the other serum chemistries, may lag behind clinical signs of injury. **$35**
- **Diagnostic peritoneal lavage (DPL)** may be indicated if abdominal penetration by a bullet is equivocal. **$450**

IMAGING CONSIDERATIONS

➔**Plain films:** Rapid AP radiographs of chest, abdomen and pelvis. Advantageous if team member places radiopaque markers on wound sites. **$156**

➔**CT scanning:** Only in stable patient with water-soluble oral, IV, and possibly rectal contrast. ***CAVEAT:*** *The surgeon must decide with great prudence when it is safe to transport a patient to the CT scanner, as it is often a remote place that requires isolation of the patient from the trauma team.* **$850**

➔**FAST examination (focused abdominal sonography for trauma):** Less helpful than in blunt trauma but may show intraperitoneal injury. **$250**

Clinical Entities — Medical Knowledge

Hemoperitoneum

Pφ Violation of the peritoneal cavity causes injury to a major blood vessel or solid organ, causing blood to collect within the abdomen. Eventually the patient exsanguinates into the peritoneum and dies from hypovolemic shock.

TP Patients present with any mechanism of abdominal penetration. Evolution proceeds through four defined classes of shock. Note key symptom markers:

Class	Lost Blood Volume	Symptoms
I	0–15%	Minimal tachycardia
II	15–30%	Tachycardia (rate >100 beats per minute), tachypnea, cool clammy skin, anxiety
III	30%	Tachypnea and tachycardia, decreased systolic BP, oliguria, confusion or agitation
IV	>40%	Hypotension, narrowed pulse pressure (or immeasurable diastolic pressure), markedly decreased urinary output, depressed mental status or loss of consciousness), cold and pale skin

Dx Dx of hemoperitoneum can be made via laparotomy, laparoscopy, or peritoneal aspirate (diagnostic peritoneal lavage [DPL]). When dx of hemoperitoneum is made via laparoscopy or DPL, laparotomy should follow, as hemoperitoneum indicates significant intraperitoneal injury that requires definitive repair.

Tx Hemoperitoneum requires rapid identification and control of the source of hemorrhage. Blood should be evacuated from all abdominal quadrants, and packing is used to tamponade bleeding prior to systematic search and control. **See Sabiston 20, 45.**

Peritonitis

Pφ Irritation and inflammation of the peritoneum caused by blood or spilled enteric contents. Peritonitis is painful to the patient and serves as a nidus for infection, sepsis, and eventual death.

TP The parietal peritoneum is extremely sensitive, and irritation of this tissue causes excruciating, often nonfocal, sharp pain. Involuntary muscular contraction or splinting produces a tense, boardlike abdomen. Free fluid and ileus produce secondary abdominal distention.

Dx Dx is confirmed by laparotomy. Laparotomy is mandatory with peritoneal signs after penetrating trauma.

Tx When the surgeon encounters peritoneal contamination, the contents should be evacuated as quickly as possible. All abdominal viscera are inspected carefully for injuries. Injured segments of intestine may be controlled temporarily with hemostats or sutures prior to definitive resection and/or repair. In cases with severe blood loss, hemodynamic instability, and physiologic derangements including hypothermia and acidosis, a temporary damage control procedure is performed. Objectives of damage control are rapid control of bleeding and immediate control of spillage from bowel injury. The patient is returned to the OR later for more definitive management of injuries and/or restoration of GI continuity. **See Sabiston 43, 45; Becker 14.**

Retroperitoneal Hematoma

Pφ Blood contained within or emanating from the retroperitoneum due to injury of retroperitoneal structures.

TP Dx Retroperitoneal hematomas are found on CT or at the time of operation. Early in the course of a laparotomy, the surgeon should investigate this anatomic space. It is divided into three zones: **zone I** includes the great vessels, and is flanked on the left and right by **zone II**, which extends out to the kidneys. **Zone III** defines the pelvic retroperitoneum.

Tx Like all vascular injuries, the first step in treating these injuries is adequate exposure, with proximal and distal control. Care must be taken when exploring the zones so as not to injure other retroperitoneal structures such as the pancreas and ureters. In some cases, angiographic embolization can be employed to control hemorrhage. In penetrating trauma, virtually all retroperitoneal hematomas are explored; in blunt trauma, exploration is mandatory only for zone I. **See Sabiston 43, 67.**

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
Management of perforating colon trauma: randomization between primary closure and exteriorization

Authors
Stone HH, Fabian TC

Reference
Annals of Surgery 1979;190(4):430–436

Problem
During World War I, colostomies were mandated in cases of penetrating colon injuries. Surgeons in subsequent wars questioned whether penetrating colon injuries could be closed primarily, or if all required a colostomy.

Intervention
Selected patients were randomized for primary closure of penetrating colon injuries or colostomy. Exclusion criteria included shock, greater than 20% blood loss, fecal contamination, more than two organs injured, delay in going to the OR, and wounds that did not require resection due to extensive tissue damage.

Quality of evidence
Prospective, randomized, nonblinded study in 268 patients with penetrating colon wounds

Outcome/effect
There was a significant decrease in perioperative morbidity (wound infection, intra-abdominal infection), a shorter length of hospital stay, and less cost, for penetrating colon injuries treated with primary closure compared to colostomy creation.

Historical significance/comments
This is the first prospective study that demonstrated improved outcome for selected patients who undergo primary colon repair.

Interpersonal and Communication Skills

"Hand-off" Communication
As the care of the patient with penetrating abdominal trauma will rely on multiple teams for multiple days, accurate transfer of complete information from team to team is crucial.

Studies have shown that a disproportionate number of health care–related sentinel events (i.e., tragedies) are associated with improper "hand-offs," the transfer of care from one health-care provider to another. Hand-off communications are clearly a vulnerable step in the provision of patient care.[1] In January 2006, the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) introduced a regulation requiring institutions to standardize hand-off procedures. Structured protocols for hand-offs are intended to minimize the communication and care-related debacles that can produce catastrophic results.

Professionalism

Principle of Social Justice; Commitment to Professional Responsibilities

With the homicide rate for youth under the age of 19 years averaging 9 deaths per day over the past decade, physicians who dedicate their careers to trauma care should be working with law enforcement professionals to create proactive community programs that can decrease the frequency of violent trauma. The CDC's Injury Center offers an online publication, entitled *Best Practices of Youth Violence Prevention: A Sourcebook for Community Action (Best Practices),* available at http://www.cdc.gov/ncipc/dvp/bestpractices.htm. This sourcebook examines the effectiveness of specific violence prevention practices in four key areas: parents and families; home visits; social and conflict resolution skills; and mentoring. Trauma prevention is a societal obligation of the profession, best accomplished by those who witness its effects on a daily basis.

Systems-Based Practice

Collaboration among the Patient Care Team across Shifts

The patient with penetrating abdominal trauma may require multiple trips to the OR for washouts and definitive repairs. In the era of the 80-hour work week and the "damage control" abdomen, the team returning a patient to the OR is often different from the team that performed the index operation. Careful attention must be paid to interteam communication, with clear documentation of each team's interventions as well as the overall perioperative plan. All members of the team should be aware of the plan for care, and the team's leaders should be in communication about short-term and long-term goals.

Reference

1. Nurs Manage 2007;38(1):10–12.

Chapter 54
Blunt Abdominal Trauma (Case 37)

Kevin M. Bradley MD and Carlos R. Medina MD

Case: A 62-year-old male presents with suspected blunt abdominal trauma resulting from a motor vehicle accident.

Differential Diagnosis

Solid organ injury (spleen, liver, kidney, pancreas)	**Hollow viscous injury** (stomach, small bowel, colon)
Vascular injury (mesenteric vessel disruption esp. elderly)	**Diaphragm rupture**

Speaking Intelligently

When I evaluate a patient injured in a motor vehicle accident, I first assess for life-threatening injuries during the resuscitation. I establish priorities in the resuscitation, and I address the **A-B-C-D-E**. After I evaluate for **A**irway, **B**reathing, **C**irculation, **D**isability, and **E**xposure, I begin the secondary survey (complete physical examination), and in this case, I focus my attention on the abdomen, looking for tenderness, guarding, distention, and rebound. I make note of injury patterns (lap belt markings, abrasions, ecchymosis), and I try to ascertain the mechanism of injury from paramedics, police, or bystanders. I remember important elements of the hx by using the mnemonic **AMPLE** (**A**llergies; **M**edications; **P**ast medical hx; **L**ast meal; **E**vents leading to presentation). If the patient is ***hypotensive*** and other life-threatening injuries have been r/o, I consider the following possibilities: hemorrhage into the abdomen, pelvic fracture with bleeding in the retroperitoneum, long bone (e.g., femur) fracture with bleeding, hemothorax, or blood loss from an open wound.

PATIENT CARE

Clinical Thinking

- Review the approach to the management of the trauma patient as needed (Chapter 47).
- **Airway:** Assess for airway patency and if the patient can protect his or her airway.

- **Breathing:** Quickly evaluate for tracheal deviation, breath sounds over each lung field, crepitus, and jugular venous distention.
- **Circulation:** Insert two large-bore (14- or 16-gauge) IV lines and start fluid resuscitation. Send a type and crossmatch specimen.
- **Disability:** Check the pupils and assess the neurological status (Glasgow Coma Scale). The spine should be evaluated for tenderness and/or step-offs.
- **Exposure:** Inspect for additional wounds and possible associated injuries once all clothing is removed. Control for hypothermia.

History

- The mechanism of injury (restrained, airbag deployment, vehicle impact and damage, prolonged extrication, ejection from vehicle) should be determined.
- Ask about loss of consciousness at the time of the accident.
- Evaluate for presence of alcohol or drug use.
- Assess for shortness of breath, chest or abdominal pain, or tenderness elsewhere.
- Gather an **AMPLE** hx and, if female, whether the patient may be pregnant.

Physical Examination

- **Initial examination:** If the patient is hemodynamically unstable, a comprehensive secondary survey is postponed (go back to the ABCs and evaluate for life-threatening injuries). Assess for reasons that may make the physical examination unreliable, such as distracting injuries (e.g., long bone fracture), altered mental state, or drug or alcohol intoxication.
- **Inspection:** Look for external signs of injuries (i.e., a pattern of injury, ecchymosis, or abrasions).
- **Auscultation:** Absence of bowel sounds may suggest abdominal injury, but ileus after trauma also is common.
- **Palpation:** Assess for tenderness, guarding, distention, or rebound. Also check for pelvic stability or tenderness and perform a rectal examination (assess the prostate and rectal tone, and evaluate stool for gross or occult blood). Presence of a high-riding prostate suggests the possibility of a urethral injury. Pelvic tenderness or instability suggests pelvic fracture.
- **Percussion:** Tenderness upon percussion may constitute a peritoneal sign. Tenderness usually mandates further evaluation and/or diagnostic studies.

Tests for Consideration

- **Blood type and screen:** Assume that all patients will require operative intervention. **$65**
- **Obtain uncrossmatched blood,** if clinically indicated. **$440/unit**

- **CBC, basic metabolic profiles, and coagulopathy parameters** are generally standard, although the yield from these tests is often low. **$120**
- **Urine hCG** should be checked in women of child-bearing age, as the management of a pregnant woman might differ greatly from that of a nonpregnant woman. **$56**
- **Serum amylase** might indicate injury to a hollow viscus but, like the other serum chemistries, may lag behind clinical signs of injury. **$35**
- **Diagnostic peritoneal lavage (DPL)** may be indicated if abdominal evaluation by focused assessment sonography in trauma (FAST) is equivocal and the patient remains hypotensive. **$450**

IMAGING CONSIDERATIONS

Editor's note: The severely injured blunt trauma patient may require an extensive radiographic evaluation. For an overview of the tests suggested below, the reader is referred to Chapter 48, Trauma Radiology Tools.

Anterior-posterior (erect, if possible) chest radiography (end of expiration) **$120**

Lateral cervical spine radiography **$50**

AP pelvic radiography **$80**

FAST: Assess for presence of free fluid in the following spaces: pericardial, hepatorenal, splenorenal, pelvic. A positive FAST examination in a hemodynamically unstable patient is an indication for laparotomy. A positive result in a patient with stable VS needs further evaluation with CT. **$190**

Depending on clinical situation:

CT of head, spine, thorax, abdomen, and pelvis: CT is performed in the patient with stable VS and abdominal tenderness, unreliable examination because of abnormal sensorium, or positive FAST examination result in the stable patient. **$800 each**

Angiography: Performed by skilled interventional radiologists in stable patients for whom CT reveals a contrast blush within a solid organ or the pelvis. **$1,100**

Clinical Entities — Medical Knowledge

Solid Organ Injury (i.e., Liver, Pancreas, Kidney, or Spleen)

Pφ Crushing forces (compression, concussion) cause subcapsular hematomas and lacerations of solid organs (spleen, liver, kidney). Deceleration forces may also be involved. An example of a classic deceleration injury is a hepatic laceration along the ligamentum teres. The pancreas is often injured when a direct blow to the epigastrum causes compression of the organ across the lumbar spine. Overall, the liver and the spleen are the most frequently injured organs.

TP Early findings may include abdominal tenderness, guarding, rebound, distention, hematuria (with renal contusion or laceration), or, in severe cases, hypotension.

Dx Findings on FAST, CT, or DPL may help in the identification and management of the injuries.

Tx CT may be used as a guide to direct nonoperative management of solid organ injuries. Angiographic coil embolization may be used for nonoperative management of stable patients who display an arterial blush in a solid organ (liver, spleen, or kidney) on CT. However, abdominal rebound tenderness, hemodynamic instability, and higher grades of solid organ injury mandate emergent laparotomy for further management. Furthermore, hypotensive patients with multisystem injuries, such as head and abdominal trauma, may need a combined emergent operative approach.

Nonoperative management of blunt solid organ injury has been used with increasing frequency. Organ injury scales are used to characterize and define the tx of the patient with solid organ injury. Hemodynamic status, presence of associated injuries, and need for blood transfusion are important considerations. The data suggest that the varied solid organs behave differently after blunt trauma and should be managed with that in mind.

Most hemodynamically stable patients with ***blunt hepatic injury*** identified by CT can be treated nonoperatively, irrespective of the severity of the hepatic injury or the quantity of hemoperitoneum. Laparotomy in a high-grade hepatic injury may be very challenging technically because of massive hemorrhage from manipulation of hepatic venous injuries. Contrast blush on CT remains an indication for angiography in the stable patient. Nonoperatively treated patients are triaged to the surgical ICU for monitoring. Indications for laparotomy include hemodynamic instability, peritoneal signs, need for ongoing blood transfusion, and presence of associated injuries that require operative therapy.

Most blunt splenic injuries are managed nonoperatively. Indications for laparotomy include grade V splenic injury with hilar disruption, hemodynamic instability, peritoneal signs, and falling hematocrit with ongoing transfusion requirements. CT findings of a blush of IV contrast may prompt angiographic intervention with embolization. Elderly patients may be more prone to failure of nonoperative therapy for management of the injured spleen. When laparotomy is performed, options for management of the injured spleen include splenectomy and splenorrhaphy, or splenic repair. Splenorrhaphy techniques include suture bolster over thrombin, fibrin glue application, or mesh wrap. Post-splenectomy pneumococcal, meningococcal, and *Hemophilus* vaccinations are provided to immunize against these encapsulated organisms.

In patients with ***blunt renal injuries***, the usual indications for surgical intervention are unstable vital signs, expanding hematoma at time of exploration, or avulsion of the renal pedicle. Hemodynamically stable patients with high-grade renal injuries and/or a blush on CT may be managed angiographically (embolization, stent, percutaneous drainage) or by laparotomy, depending on the institutional preferences and resources. Urologic consultation should be obtained.

Blunt pancreatic injuries usually require operative interventions ranging from simple drainage to partial or total pancreatic resections, depending on severity of injury. It is particularly important to evaluate for associated injuries (duodenum, inferior vena cava). The need for enteral access should be considered. Octreotide is an antisecretagogue analog of somatostatin that is used to control pancreatic fistula drainage that may develop postoperatively in these patients. **See Sabiston 20, Becker 11.**

Hollow Viscous Injury (Stomach, Duodenum, Small or Large Intestine)

Pφ Compression from a lap belt and concussive forces may deform hollow organs, transiently increasing the intraluminal pressure and resulting in rupture. The bowel wall injury may be partial, producing a mural hematoma, or a full-thickness rupture. Gastric injuries are rare and usually occur with a forceful blow to the abdomen in the presence of a closed glottis. The injury is usually at or near the gastroesophageal junction. The duodenum may be injured with direct forces applied to the epigastrum.

TP Clinical findings may include a tender abdomen, often with guarding or rebound. As these injuries may initially be occult, and only become evident over time, close observation and serial abdominal examinations are needed. Patients with duodenal injuries may exhibit excessive nausea and projectile vomiting due to outlet obstruction.

Dx Dx is made rarely by FAST examination, as the small amount of extravasated fluid may be undetected. A DPL may be positive. A CT scan may show mesenteric stranding, bowel wall thickening suggestive of hematoma, free fluid, or free air. A CT showing abdominal fluid in the absence of a solid organ injury should raise suspicion for a hollow visceral injury. A chest radiograph may show free air under the diaphragm. A Gastrografin upper GI series will help to further evaluate the duodenum, which, if injured, may demonstrate a stack-of-coins appearance.

Tx Small intestine and colonic injuries are treated with laparotomy and repair or resection of the injured bowel. The mesentery of the involved bowel should be closely inspected and pulses palpated or evaluated with Doppler ultrasonography. When resection is performed, proximal small bowel injuries are generally treated with primary anastomosis; for more distal and colonic injuries, the decision for anastomosis or ostomy depends on transfusion requirements, degree of fecal spillage, and associated injuries.

For duodenal injuries, exploration is generally indicated. Isolated and lesser degrees of injury or late presentation may be managed with NG tube decompression in stable patients without signs of inflammation (fever, tachycardia, elevated WBC count, or peritoneal signs). A Gastrografin upper GI series is used to evaluate luminal patency and free extravasation of contrast. These patients should be monitored closely and examined serially in a surgical ICU. At laparotomy the duodenum is fully mobilized to examine extent of injury, and the pancreas is carefully inspected. Management options include tube drainage, exclusion procedures to bypass the injured segment, limited resections, duodenal to jejunal bypass, and jejunal serosal patches. Wide drainage and enteral access are key principles in managing duodenal injuries. **See Sabiston 20.**

Vascular Injury (Mesenteric or Renal Arterial Injury)

Pφ Deceleration forces cause stretching at the junction between free and fixed segments of arteries. These subsequent shearing forces tend to cause thrombosis, mesenteric tears, and avulsion injuries. Calcified vessels in the elderly may be more prone to injury. Avulsion of the superior or inferior mesenteric arteries usually occurs in the elderly and may represent a life-threatening injury due to the potential for blood loss and associated loss of bowel length. Loss of viable bowel length may lead to short gut syndrome.

TP Initial findings may include hypotension, tachycardia, and abdominal tenderness.

Dx Positive findings on FAST examination, CT revealing mesenteric thickening from a hematoma, IV contrast blush, or positive DPL may help in the identification and management of the injuries.

Tx The appropriate tx is laparotomy for further evaluation and possible repair of the arterial injury along with assessment of intestinal viability. When bowel viability is in question, a second-look laparotomy is indicated within 24 to 48 hours to determine the need for further bowel resection. **See Sabiston 20, 67; Becker 11.**

Diaphragmatic Rupture

Pφ ***Diaphragmatic rupture*** may occur after any forceful blow to the upper abdomen, such as may occur with motor vehicle trauma, animal kicks, or cave-ins. These patients often have associated thoracic and/or abdominal injuries or may have concomitant head or extremity trauma. The negative inspiratory pressure within the pleural space may draw abdominal viscera into the thorax on the affected side.

TP A hx of respiratory difficulty and related pulmonary symptoms may be present. A diaphragm injury occasionally may be identified by auscultation of bowel sounds in the chest or dullness on percussion of the involved hemithorax.

Dx A chest radiograph is the single most important diagnostic study and may show an elevation of the hemidiaphragm, a bowel gas pattern in the chest, or an NG tube that passes into the abdomen and then curls up into the chest. The liver often protects a right-sided rupture from visceral herniation, and these ruptures therefore may appear only as an elevated hemidiaphragm from a partially herniated liver. Left-sided ruptures are more evident when the bowel is herniated into the chest cavity.

Tx Surgical management consists of laparotomy to search for associated injuries and repair of the defect in the diaphragm. Some of these injuries may present in a delayed fashion months to years later, usually with abdominal pain, dyspnea, or bowel obstruction, and present challenges in management, as there may be loss of abdominal domain with chronic herniation of viscera into the thorax. **See Sabiston 20.**

ZEBRA ZONE

Chance fracture is a fracture of the vertebral body from T12 to L4 (highest incidence at L2). The injury occurs typically in a back seat passenger restrained by a lapbelt and involved in a motor vehicle accident or resulting from a fall from a height). Flexion-distraction forces are responsible for the Chance fracture. The patient complains of back pain and may have a lapbelt abrasion across the abdominal wall. Thoracolumbar radiographs will identify these fractures, which require evaluation by a spine surgeon. Be aware of a high incidence of associated intra-abdominal injuries, including the liver, spleen, pancreas, or intestine. **See Sabiston 20, Becker 45.**

Practice-Based Learning and Improvement: Morbidity and Mortality: Self-Assessment Form

Complication	Infected hematoma/LUQ abscess following splenectomy for trauma
Type	Technical error; preventable
Surgery performed	Splenectomy
Patient's disease	63-year-old man with a grade V splenic laceration after motor vehicle accident
Presentation	Fever, leukocytosis, fluid collection on CT on POD #5
Intervention	CT-guided percutaneous drainage and IV antibiotics directed at organisms cultured from abscess. Follow-up CT to document resolution of abscess.
Outcome	Abscess resolved, percutaneous drain removed after 10 days, and patient discharged home.
Risk factors	Excessive blood loss, age
How were risks addressed?	Meticulous hemostasis; careful search for other injuries; perioperative antibiotics
What happened?	Postoperative fever and leukocytosis prompted abdominal CT on POD #7.

What could have been done differently?	Better hemostasis; meticulous aspiration of fluid from the abdominal cavity (blood, irrigation, etc).
Would outcome have been different?	Drainage procedure and prolonged hospitalization might have been avoided.

Interpersonal and Communication Skills

Be Careful of Your Side Conversations

Remember in the ED, trauma bay, and elsewhere: *Watch your extraneous side conversations:* the patient is NOT interested in how you spent your weekend or with whom you had dinner last night. Being exposed to such conversations sends a message that the patient is not your prime concern.

Professionalism

Commitment to Maintaining Appropriate Relations with Patients

While performing the initial trauma evaluation (ABCDE) and FAST, the patient will be completely exposed (all clothing is removed). Though protocol requires that all of the patient's clothing be removed, a patient's modesty should be respected and the patient's body covered as soon as comprehensive assessment has been completed.

Systems-Based Practice

Operations: The Logistics of Patient Transfers

I (D.L.) practice in a rural setting where resources are limited. When a multisystem trauma patient arrives in our ED, assessment of injuries and stabilization take place in accordance with ATLS protocols. Thinking ahead is key to optimizing patient outcome. Take, for example, a young patient involved in a motor vehicle crash (blunt trauma to head and abdomen) who is hypotensive in the ED, has an open femur fracture, dilated pupil, respiratory distress, and distended abdomen. As soon as I receive the call at home, thinking ahead allows me to mobilize available resources immediately as time is crucial. Given the abdominal distention and hypotension, I think of intra-abdominal bleeding, which will need to be corrected prior to transfer. Ultimately this patient will require a neurosurgeon. The nearest trauma center will be alerted of the potential head injury and, after the spleen is removed and the blood pressure stabilized, a call will be placed directly from the OR to arrange acceptance of the patient. The patient will be transferred directly out of the OR into a helicopter for transport.

Chapter 55
Pelvic Fracture (Case 38)

Saqib Rehman MD

Case: A 64-year-old female T-boned on the passenger side of the car in a motor vehicle crash.

Differential Diagnosis

Stable pelvic fracture	Unstable pelvic fracture
Open pelvic fracture	Bladder/urethral injury

Speaking Intelligently

Pelvic fractures are typically the result of significant blunt trauma or less significant trauma in osteoporotic bone. In either scenario, I take pelvic fractures very seriously since massive hemorrhage can occur, leading to exsanguination. Pelvic fractures and their sequelae are often not dramatically apparent. Therefore, I perform a thorough physical examination including the rectum and vagina in order to avoid missing occult open pelvic fractures, neurovascular injury, and urologic injury. A single AP pelvic radiograph is usually sufficient to identify an unstable fracture pattern that might require immediate tx maneuvers such as ***fluid resuscitation***, ***fracture reduction with a pelvic binder or external fixation***, and/or ***angiography***. Thromboembolism is a hidden danger with pelvic fracture patients, and I pay attention to appropriate prophylaxis.

PATIENT CARE

Clinical Thinking

- It can be easy to lose sight of the ABCs in patients with obvious, isolated musculoskeletal injuries on presentation. Don't fall into this trap! Review the ABCs.

History

- What was the mechanism of the injury? Was there a high-energy trauma such as a motor vehicle crash or a fall from a height? If it was a motor vehicle crash, was the patient belted or not? Was the patient in the vehicle or a pedestrian? Or was it a low-energy trauma such as a trip and fall?

- Does the patient complain of numbness, tingling, or weakness in the lower extremities?
- **AMPLE** (**A**llergies; **M**edications; **P**ast medical hx; **L**ast meal; **E**vents leading to presentation).
- Very important to know about previous hx of cardiovascular or peripheral vascular disease.

Physical Examination

- Physical examination starts with a primary survey—the ABCs.
- **Airway:** Ensure that the airway is patent and protected.
- **Breathing:** Check that breathing is not labored and/or tachypneic. Breath sounds should be equal bilaterally, and the trachea should be midline.
- **Circulation:** Check the blood pressure, heart rate, and pulses. Hypotension can be an indication of hemorrhage in the trauma patient.
- **Disability:** Check for gross deformities, wounds, and contusions.
- **Exposure:** Don't forget to roll the patient to check the back and buttocks. The secondary survey should include the other pertinent body systems, particularly the nervous system, musculoskeletal system, and genitourinary systems.

- Leg length discrepancy can be an indication of injury to the extremities or can occur in vertically unstable pelvic fractures.
- Pelvic instability to gentle distraction and compression at the iliac crests should be checked, but not repeatedly.
- Motor function, sensation, and reflexes should be checked, particularly in the lower extremities in a patient with a pelvic fracture. A footdrop from sciatic nerve injury may occur, or concomitant spinal injury may lead to abnormal neurological examination results.
- A rectal examination to check for bleeding and sacral motor function is necessary, as is a vaginal examination to check for bleeding. Bleeding in these areas may indicate an open pelvic fracture.
- Blood at the urethral meatus or after passing a Foley catheter likely indicates a bladder or urethral rupture.

Tests for Consideration

- Blood typing and screening **$65**
- **CBC with automated differential:** Looking for adequate platelet count and baseline hemoglobin. **$34**
- **PT/PTT:** Looking for coagulopathy that would require correction to stop bleeding. **$56**
- **ABG tests and serum lactate levels** can indicate the degree of blood loss suffered by the patient and help determine when a patient has been adequately resuscitated. **$156**

- **Supraumbilical diagnostic peritoneal lavage (DPL)** is typically considered the gold standard for determining if there is intraperitoneal bleeding. **$450** However, ***focused abdominal sonography for trauma (FAST)*** is acceptable if performed by experienced staff. **$250**
- **Cystourethrography** is helpful to rule out urinary tract injury such as urethral injury and bladder rupture, not uncommon in patients with pelvic fractures. **$775**

IMAGING CONSIDERATIONS

➔**Plain radiographs:** AP film of the pelvis. Additional oblique views can be performed when stable. **$200**

➔**CT:** Thin-section CT can be reformatted into 3D images of pelvic fractures. Best means of evaluating acetabular and posterior pelvic fractures. Best means of showing soft tissue injury. **$850**

➔**Angiography:** Only necessary when the vascular injury is suspected. Interventional techniques can be used to treat such injuries. **$2,000**

Clinical Entities — Medical Knowledge

Stable Pelvic Fracture

Pφ There may be fractures causing a break in the pelvic ring, or fractures such as avulsion fractures or isolated fractures of the iliac wing not causing a break in the pelvic ring. The ligaments of the pelvic floor, including the sacrotuberous and sacrospinous ligaments, as well as the posterior ligaments, including the posterior sacroiliac ligaments, are intact. This renders the pelvis biomechanically stable.

Avulsion fractures may occur from low-energy trauma, such as a minor sports injury. Stable pelvic ring fractures may also occur from low-energy trauma, such as a fall in a patient with osteoporosis or a metastatic lesion to the pelvis.

TP Gross deformity is not seen on physical examination, and hemorrhage is less likely.

Dx Dx is made by radiographic classification criteria. Typically, stable fractures are minimally displaced due to the intact ligaments as described above. Furthermore, a double break in the pelvic ring is generally not seen.

Tx Early mobilization and protected weight bearing is the rule. Often, weight bearing as tolerated is allowed with the protection of an assist device such as crutches or a walker. Serial radiographs are done to ensure no displacement of fragments. **See Sabiston 21, Becker 11.**

Unstable Pelvic Fracture

Pφ There are two types of mechanical instability: rotational, and rotational with vertical instability. Rotational instability can result from an "open book" injury in which the ligaments of the pelvic floor, anterior sacroiliac ligaments, and pubic symphysis are disrupted. Alternatively, a "lateral compression" injury can occur in which the hemipelvis is displaced inward, causing multiple anterior ring fractures and a stable posterior fracture. Vertical instability, however, is due to a complete disruption of the pelvic ring both anteriorly and posteriorly. Branches of the internal iliac artery such as the superior gluteal artery can lead to arterial retroperitoneal hemorrhage. However, venous bleeding and bony bleeding often account for more blood loss than arterial disruption.

TP These patients may present with pelvic hemorrhage and pelvic instability on physical examination. X-rays will show the fractures or open book dislocation pattern as described above.

Dx Dx is made by radiographic classification criteria. The presence of vertical displacement posteriorly must be determined.

Tx Pelvic binder application or external fixation may be required emergently, particularly in displaced open book patterns, in order to reduce the pelvic volume and tamponade hemorrhage. The proper sequence of tx for hemorrhage is somewhat controversial. Angiographic methods of hemostasis may be helpful for cases of arterial hemorrhage. Be aware that angiography can only help with arterial bleeding, but not with venous and bony bleeding. If laparotomy is performed, it is important to realize that tamponade can potentially be reversed risking further blood loss. Pelvic packing and damage control techniques are typically utilized if laparotomy is necessary. Finally, in many cases it may be necessary to defer orthopedic surgical reconstruction until after the patient has been stabilized. **See Sabiston 21, Becker 11.**

Open Pelvic Fracture	
Pφ	As with all open fractures, there is a direct communication of the fracture with the environment through a break in the skin, rectum, or vagina.
TP	High-energy trauma is usually the case, though penetrating trauma such as gunshot injuries may also occur. Perineal lacerations may be present, with or without evisceration. Rectal or vaginal examination may reveal bleeding and/or bony fragments.
Dx	Dx is made simply by the existence of a communication with the environment as described above. In questionable cases, intrapelvic air may be seen on CT, indicating communication.
Tx	Tx is similar to that for other pelvic fractures as described above. However, the risk for intrapelvic sepsis mandates emergent irrigation and debridement of the wounds. For wounds involving the perineum, rectum, and vagina, diverting colostomy is required to prevent subsequent fecal contamination. The only exceptions are for some low-energy gunshot wounds without fecal spillage. Prophylactic antibiotic tx is also required. **See Sabiston 21, Becker 11.**

Bladder/Urethral Injury	
Pφ	The intimate relationship of the urinary bladder and urethra to the anterior pelvis make them susceptible to injury in pelvic ring injuries. Bladder rupture can be intraperitoneal or extraperitoneal.
TP	The patient may have blood at the urethral meatus or gross hematuria after passing a Foley catheter.
Dx	Along with the presentation as described, retrograde cystourethrography confirms the dx. When a urethral injury is suspected (as when blood is discovered at the urethral meatus), it is important to remember that a Foley catheter should *not* be inserted until retrograde cystourethrography is performed.
Tx	Intraperitoneal bladder rupture typically requires urgent repair. If anterior bony reconstruction such as symphyseal plating is required, this is performed at the same setting. Extraperitoneal bladder ruptures usually do not require repair; but if anterior plating is required, bladder repair should be done at the same setting to prevent hardware infection. Suprapubic catheters should be avoided and prolonged Foley catheterization is usually required. **See Sabiston 20.**

ZEBRA ZONE

Prior fractures and growth centers: Occasionally, prior fractures in various stages of healing may be apparent on the pelvic radiograph of a trauma patient. It is important to correlate the hx and physical examination with these findings to determine if findings on x-ray are new injuries or not. The triradiate cartilage of the acetabulum and normal secondary growth centers at the iliac crest, anterior superior iliac spine, and ischial tuberosity in the skeletally immature patient can mimic fractures to the inexperienced clinician. Again, hx and physical examination and search for a bilateral symmetry on the radiograph should help avoid this mistake.

Practice-Based Learning and Improvement: Morbidity and Mortality: Self-Assessment Form

Complication	Deep venous thrombosis (DVT) after pelvic fracture.
Type	Error in judgment; delay in tx; possibly preventable
Surgery performed	None
Patient's disease	23-year-old woman with superior-inferior ramus fractures after motorcycle accident
Presentation	Lower extremity pain and swelling on sixth day after injury, femoral DVT seen on lower extremity duplex
Intervention	Therapeutic anticoagulation with low-molecular-weight heparin, followed by oral anticoagulation with warfarin
Outcome	Symptoms improved; patient mobilized with physical therapy
Risk factors	Pelvic fractures, immobilization
How were risks addressed?	Pneumatic compression devices were used, but patient complained about these so they were not always on. Physical therapy was ordered but had not begun.

What happened?	Patient complained of thigh pain and leg swelling.
What could have been done differently?	Prophylactic anticoagulation. The patient did not have a head injury or pelvic bleeding as contraindications to anticoagulation. Earlier attempts at mobilization also might have helped, as well as continuous use of pneumatic stockings while at bed rest.
Would outcome have been different?	Long-term therapeutic anticoagulation might have been avoided, and the hospitalization would probably have been shorter.

Interpersonal and Communication Skills

Endotracheal Intubation: Communication and Reassurance

As patients with pelvic fractures may eventually require endotracheal intubation for airway and/or pulmonary issues, it is important to communicate with the trauma patient early and comprehensively. A proper secondary survey and neurologic exam can be quite limited if the patient cannot speak or follow commands due to medications or intubation. Emergency contact information and surgical consents should be obtained while the patient can speak. Then remember that the process of endotracheal intubation itself can be frightening for the patient. Reassure the patient and explain the need for the "breathing tube." Continue talking to the patient to provide reassurance. Elicit the patient's level of comfort, understanding, and wishes through hand and eye "yes" and "no" signals or other non-verbal approaches. In addition, remember that even though patients cannot respond, they may be able to perceive everything that is transpiring around them.

Professionalism

Commitment to Improving Quality of Care

Pelvic fracture management requires smooth, coordinated interdisciplinary care between emergency physicians, trauma surgeons, orthopedic surgeons, radiologists, and urologists. It is crucial that each team understands its own role and each other's role in order to achieve efficient and high-quality patient care. Following the acute phase of care, connecting the patient to a rehabilitation specialist is imperative. Attention to the "big picture" as well as the details is important in preventing patient morbidity and long-term disability from the pelvic fracture.

Systems-Based Practice

Standardization of Practices

Evidence-based practices have been shown to enhance the safety of patient care, especially in the ICU. The consistent use of all relevant preventive measures for a complication is called *bundling*. Bundles exist for preventing many complications, including ventilator-associated pneumonia (VAP) and central venous catheter–associated bloodstream infections. Dramatic success in reducing complications has resulted from successful implementation of all elements of a bundle.

The bundle for preventing VAP consists of raising the head of the patient's bed between 30 and 40 degrees, stress ulcer prophylaxis, DVT prophylaxis, gradually reducing the use of sedatives each day, and daily assessments of the patient's ability to breathe without the assistance of a ventilator.

The bundle for preventing central venous catheter–associated bloodstream infections consists of good hand hygiene, full sterile barriers on insertion of the catheter, chlorhexidine skin antisepsis, use of optimal sites for catheter insertion, and daily review of the necessity of the central venous access, with prompt removal of unnecessary central IV lines.

Safer care is often a matter of conscientiously following all the steps of patient care protocol that have been demonstrated to yield optimal results.

If you have had the opportunity to participate in the care of a trauma patient, you are encouraged to review your patient's course in the context of the Competency Self-Assessment Form on page 35, which can also be found as a Word document on the book's Web site on www.studentconsult.com. Give some thought to how well the trauma "system" worked for your patient. Could you improve upon it?

Professor's Pearls: Trauma

Section Review

Consider the following clinical problems and questions posed. Then refer to the professor's discussion of these issues.

1) An 18-year-old male sustains a stab wound to the left chest just lateral to the left nipple. Upon presentation to the ED, the patient complains of shortness of breath and left chest pain at the site of the stab wound. Heart rate is 110 and BP is 90/55. Examination shows jugular venous distention (JVD), tracheal deviation to the right, and decreased breath sounds in the left chest. Abdomen is nontender and nondistended. There are no other stab wounds to the chest, back, or extremities. Neurological examination reveals a somewhat agitated patient and a nonfocal examination.

What do you identify as the major issues? What are your most immediate concerns?

2) A 30-year-old male is brought to the ED after a motor vehicle crash in which he was the belted driver of a car that was t-boned on the left side, with passenger space intrusion. BP is 110/70; pulse is 105; there is a bruise on the forehead; abdomen shows a shoulder belt contusion across the left chest and right upper abdomen. The patient moves all extremities, but mental status shows agitation, disorientation, and repetitive questioning.

What are the priorities of management? What are the likely injuries, and how should they be evaluated?

3) A 23-year-old male is thrown from a motorcycle and then struck by a car. In the ED, he has BP 140/90, pulse 100, and a swollen, deformed left lower extremity with intact skin.

What are your major concerns in this patient, and how should they be evaluated? What diagnostic studies are indicated? What are the principles of management?

Discussion by Jonathan R. Hiatt, MD, Chief, Division of General Surgery; Director, Surgical Education, David Geffen School of Medicine at UCLA

Answer 1

Initial priorities in management of the trauma victim are always the same and include attention to airway, breathing, circulation, neurological impairment, complete exposure of the patient, and control of the resuscitation environment. I emphasize that we not only *assess* each of the ABCDEs, but we also *manage* them and never move onto the next letter until we have dealt with the current one. We get control of the airway; we find impairments to breathing and correct them; we get control of the circulation by starting IV lines and drawing blood for crossmatch.

This patient has a patent airway but a problem with breathing. He has signs of a tension pneumo- and/or hemothorax and requires immediate chest decompression with a needle in the second interspace, midclavicular line (above the rib, because the vessels run below), followed by tube thoracostomy. These interventions should not be delayed for CXR, although x-ray is useful if obtained immediately. Resuscitation should continue with placement of large-bore IVs, infusion of saline or Ringer's lactate, and chest radiography. The patient is at risk for injuries to the heart, left diaphragm, and abdominal viscera in addition to the lung, pulmonary hilum, and great vessels. FAST examination should be performed as the initial screen. The diaphragm is at risk in any stab wound below the nipples and near the costal margin. Diaphragmatic injuries can be relatively silent, particularly in penetrating trauma, and may require operative laparoscopy for dx; identification and repair are obligatory, as complications including entrapment of stomach or colon may occur if the injury is missed, with presentation within hours or days but also delayed for years or decades.

Answer 2

Major blunt trauma places all organs and systems at risk for injury, but the nature of the impact and other details of the accident do raise suspicion for specific injuries. With left-sided impact and passenger space intrusion, the driver is at particular risk for injuries on the left side of the body, including the chest cavity, abdomen, spleen, left kidney, and left colon. The seatbelt sign also is a marker for injury and raises concern for trauma to the left chest and liver. (When a lapbelt contusion is present, intestinal injuries should be considered, and presentation may be delayed and subtle.)

The statement that an ED patient is "hemodynamically stable" at the outset of management is a pet peeve of mine, because stability implies a period of observation; also, the statement is often based on VS that are at best a crude index of perfusion. This patient is at risk for major chest and abdominal trauma, and he definitely has a head injury, which must raise suspicion of cervical spine injury as well. At this moment, we can't say that he's stable with any authority or confidence, and the evaluation has to proceed.

As always, we begin with ABCDEs, in that order. With depressed mental status in a patient who may be unable to protect the airway, the airway must be secured. The cervical spine is similarly protected and considered injured until proven otherwise. Breathing is evaluated by examination and x-ray, IV lines are placed, and a GCS score is calculated. If VS don't deteriorate during these initial evaluations, the patient is a candidate for further dx with CT. (FAST examination is performed in the ED, but without signs of significant and ongoing hemorrhage, the finding of fluid on FAST would probably not be an indication for a laparotomy without CT.) This patient needs CT of the head, abdomen, and pelvis, and we usually add the neck and chest, as high-speed scanners can do the tests quickly and answer many questions at the outset of management.

Blunt solid organ injuries to the liver, spleen, and kidneys often are managed nonoperatively if the surgeon can be confident that the bleeding has stopped. The patients must be followed very closely, usually in an ICU, with the option to change course and perform a laparotomy at any time. Indications for early operation would include large hemoperitoneum, ongoing bleeding, or presence of distracting injuries (such as major fractures) that will make it difficult to evaluate the abdomen. Ongoing bleeding may be demonstrated by clinical signs including hemodynamic instability and continuing transfusion requirements and by a contrast blush on CT (sometimes managed with angiographic embolization). Late operative indications include ongoing bleeding or development of new peritoneal signs. The presence of a head injury must be considered and may be an indication for abdominal exploration, especially if continued bleeding might produce hypotension and secondary brain injury. An algorithmic protocol for nonoperative management and observation by a single responsible surgeon are absolutely essential.

Answer 3

The combination of injuries in this patient was not covered in the text but is important to understand. While all organ systems are at risk, and the obligatory ABCDE approach must be followed, he clearly has a major injury to his lower extremity that must be evaluated with physical examination and additional special studies.

We look for physical findings of impaired perfusion in the leg, including abnormalities or absence of pulses and delay in capillary refill. Sensory and motor examinations give further information about the extent of injury. Comparison with the uninjured extremity is crucial—are perfusion and/or neurological abnormalities unilateral, suggesting a local problem, or bilateral, suggesting a more proximal or systemic problem? If pulses are absent, a Doppler examination using a handheld sensor may be performed, but any pulse abnormality is significant, especially if asymmetric.

X-rays of the leg should be performed. The presence of a fracture (tibia and/or fibula in this case) in a closed space raises the concern of a compartment syndrome, which occurs when tissue pressure exceeds perfusion pressure and causes ischemic injury.

Compartment syndrome is a clinical dx that is suspected based on mechanism of injury and subjective and physical findings. Findings include the five P's of acute ischemia (pain, paresthesias, pallor, pulselessness, and paralysis) and represent a continuum or progression that can be interrupted with prompt dx and tx. Compartment pressures help to substantiate the dx and can be measured with needle manometry or diagnostic tonometers.

Untreated compartment syndrome causes a number of major problems. The greatest of these is limb threat from ongoing direct injury to tissues and nerves. Muscle breakdown, or rhabdomyolysis, may cause renal damage by precipitation of myoglobin in the renal tubules.

Management principles include, first, ABCDEs as for any trauma patient, then suspecting the dx of compartment syndrome and evaluating the limb for fractures and elevated compartment pressures. When compartment syndrome is confirmed, the affected compartments are decompressed with surgical fasciotomy. Operative details of lower extremity fasciotomy are found in any orthopedic text.

The urine should be examined for myoglobin. Quantitative determination is available, but a quick method allows for rapid dx: with myoglobinuria, the urine dipstick will identify myoglobin as hemoglobin and test positive for blood, but no red cells will be found on microscopic examination. If myoglobinuria is present, the urine should be alkalinized by administration of IV bicarbonate, as myoglobin precipitates in an acidic environment.

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Chapter 56
Teaching Visual: The Roux-en-Y Limb

Barry D. Mann MD

Objectives

- Draw a Roux-en-Y limb and discuss its applications in abdominal surgery.
- Draw a Roux-en-Y limb for your patient in the context of describing gastric bypass.

Medical Knowledge

Note points A, B, and C in the drawing on the left in Figure 56-1. To create a Roux-en-Y limb, cut the jejunem at the line between A and B. "Pull up" point B of the mobile jejunem as shown in the figure on the right.

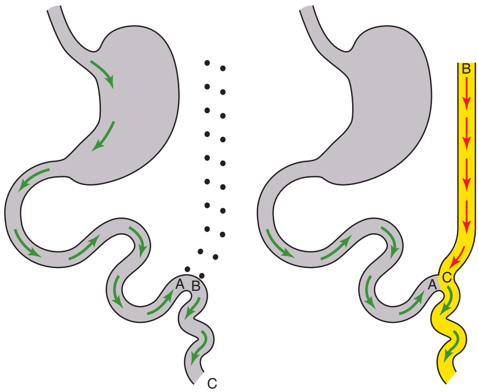

Figure 56-1 The Roux-en-Y limb. The arrows indicate the direction of peristalsis.

The green arrows demonstrate the normal food stream. Note that in the Roux-en-Y limb, point B to point C is now out of the food stream, yet the limb still has antegrade peristalsis (red arrows).

This makes the Roux-en-Y limb a very valuable tool, which (like a vacuum cleaner) can collect secretions and drainage from a proximal source and deliver it distally.

After you master (and can draw) a Roux-en-Y limb, study some of its applications on the following pages.

The patient in Figure 56-2A, for example, has a Klatskin tumor, a cholangiocarcinoma at the confluence of the right and left hepatic ducts. Though the bile ducts could be sewn into a *loop* of jejunem, this would allow the food stream to pass too closely to the biliary tree and runs the risk of ascending cholangitis. A **Roux-en-Y hepaticojejunostomy,** being isolated from the food stream, solves this problem.

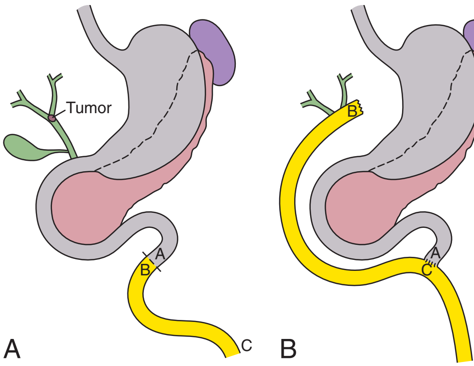

Figure 56-2 Roux-en-Y hepaticojejunostomy

In Figure 56-3, note that a total gastrectomy is performed for gastric carcinoma. The duodenum cannot be mobilized to reach the distal esophagus. The Roux-en-Y limb can reach to create a **Roux-en-Y esophagojejunostomy.**

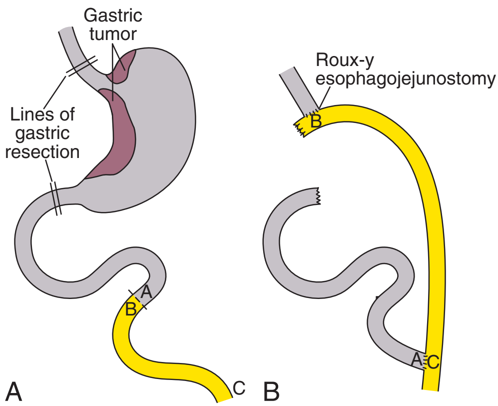

Figure 56-3 Roux-en-Y esophagojejunostomy.

Figure 56-4 depicts the pancreas of a patient with chronic pancreatitis, where the pancreatic duct is markedly dilated (often called a "chain of lakes"). In Figure 56-4B, the Roux-en-Y limb is sutured directly to the pancreatic duct (a Puestow procedure), creating a **Roux-en-Y pancreaticojejunostomy**.

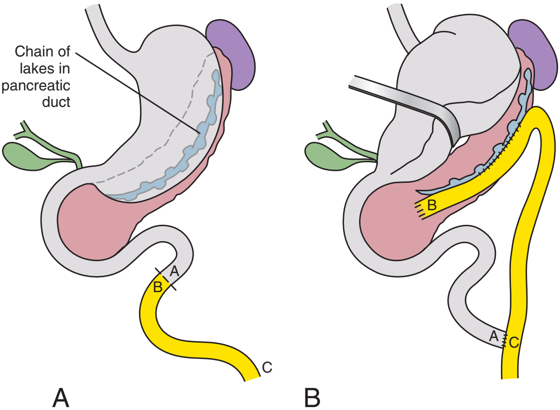

Figure 56-4 Roux-en-Y pancreaticojejunostomy.

Figure 56-5A depicts a pancreatic pseudocyst in the tail of the pancreas. The Roux-en-Y limb is sutured to the cyst wall for internal drainage, creating a **Roux-en-Y pancreaticocystjejunostomy**.

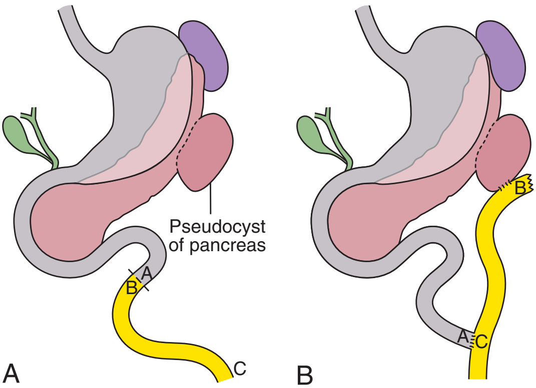

Figure 56-5 Roux-en-Y pancreaticocystjejunostomy.

Interpersonal and Communication Skills

Diagram a gastric bypass for your patient:

1. Connect the dots to complete the normal anatomy of the upper GI tract in Figure 56-6A.
2. Demonstrate creation of the gastric pouch (transection of the proximal stomach at line xy) and formation of the Roux-en-Y limb (transection of the jejunem at point A–B) in Figure 56-6B.
3. "Pull up" the Roux-en-Y limb to the gastric pounch by connecting the dots in Figure 56-6C. Demonstrate the anastomosis of the Roux-en-Y limb to the pouch (dotted circular symbol) and the anastomosis of the Roux-en-Y limb distally at point C to the proximal jejunem (often called the "biliary pancreatic limb" of the Y).

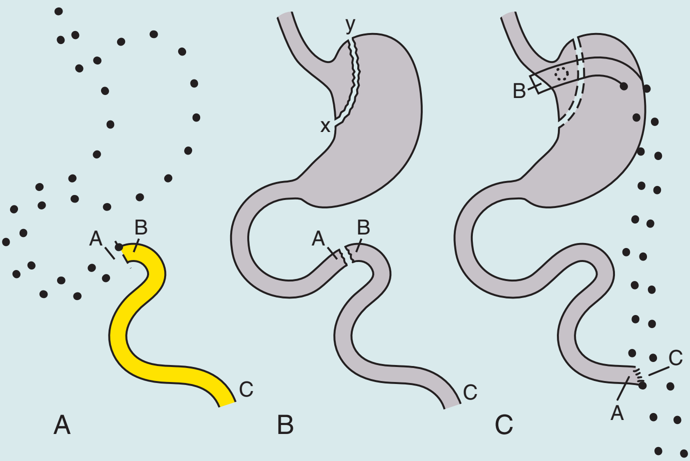

Figure 56-6 Roux-en-Y pouchjejunostomy.

Chapter 57
Gastric Bypass (Case 39)

Lisa R. Weisfelner MD and Andres E. Castellanos MD

Case: A 37-year-old female presents for consideration of gastric bypass.

Obesity Comorbidities

The following are among the most **common** comorbidities to be considered when evaluating a patient for gastric bypass:

Diabetes	Sleep apnea	Depression
Hypertension	Joint paint	Gastroesophageal reflux disease (GERD)

Speaking Intelligently

When I encounter a patient requesting gastric bypass surgery, I must determine if the patient is a good candidate for the procedure. I consider body mass index (BMI) and medical comorbidities, and I follow the recommendations of the National Institutes of Health (NIH) and the American Society for Metabolic and Bariatric Surgery (ASMBS).

The most important criterion after BMI is personal motivation to change current lifestyle. To select the right candidate for surgery, I rely on a multidisciplinary approach, which includes seeking the advice of a nutritionist and a psychologist.

PATIENT CARE

Clinical Thinking

- Obesity is a chronic disease with comorbid factors worsening over time. Important comorbidities recognized in obese patients are type II diabetes, hypertension, arthritis, sleep apnea, hypercholesterolemia, and GERD.
- Ideal body weight tables, waist circumference, or BMI are used to qualify patients for surgery. BMI, which is used most often, is a measurement of weight adjusted for height and is measured in kg/m^2, calculated by the following formula (note conversion for pounds and inches):

$$\text{BMI} = \frac{\text{weight in kg}}{(\text{height in meters})^2} \quad \text{or} \quad \text{BMI} = \frac{\text{weight in } \textbf{lb} \times \textbf{703}}{(\text{height in } \textbf{inches})^2}$$

Categories of BMI:

Category	BMI
Normal	18.5–24.9
Overweight	25.0–29.9
Obesity	
Type I	30.0–34.9
Type II	35.0–39.9
Morbid obesity	40.0–49.9
Super-obesity	>50

- Candidates for gastric bypass should have a body mass index (BMI) of 40 or higher, approximately 100 lb over ideal body weight
- In certain instances patients with BMIs between 35 and 40 may be considered for surgery if they have medical comorbidities likely to be ameliorated by gastric bypass (e.g., severe sleep apnea, obesity-related cardiomyopathy, severe diabetes).
- A good surgical candidate (1) meets criteria for morbid obesity, (2) has no endocrine cause of obesity, (3) is an acceptable operative risk, (4) understands the surgery and the risks, (5) has no drug or alcohol problem, (6) has no uncontrolled psychological conditions, and (7) is dedicated to lifestyle change and long-term follow-up.

History

- Ask why the patient is presenting to you for bariatric surgery. This should remain an open-ended question.
- An accurate picture of the patient's weight problem should include the following:
  - Initial onset, lowest and highest adult weight, effect of weight on daily life, and hx of eating disorder.
  - Family hx of obesity.
  - Current diet habits, including frequency and content.
  - Diet medications and programs already tried with amounts lost and regained.
  - Exercise hx, including physical limitations.
- Social hx should include marital status, family composition, support system, smoking, drug and alcohol hx, and identifiable stressors. If the patient has seen a mental health professional for any reason, this should be discussed and noted.
- The past medical hx should include a detailed hx of all comorbid conditions. Past surgical hx is important to assess the patient's risk for general anesthesia.

Physical Examination

Performing a thorough physical examination in obese patients can be difficult and challenging. Look for signs of undiagnosed disease related to obesity.

Specific examination findings requiring close attention include:

- ***Head and neck:*** Look for potential airway problems. Short neck. Prominent tonsils and adenoids. Enlarged thyroid.
- ***Cardiovascular:*** Document the presence of edema and peripheral pulses.
- ***Respiratory:*** Check expiratory effort. Listen to both lung fields for inspiratory and expiratory wheezing.
- ***Abdominal:*** Note previous scars and abdominal wall hernias.
- ***Extremities:*** Morbidly obese patients are at risk for DVT (even pre-op and certainly postsurgery). Careful pre-op exam is required.

Tests for Consideration

Consultations and evaluations should be individualized.

• **Nutrition consultation:** Mandatory in all patients.	**$50**
• **Pulmonary evaluation:** Most centers require pulmonary function tests. A formal sleep study may be required if the patient has sleep apnea.	**$150–400**
• **Cardiac evaluation:** Based on hx and risk factors, an EKG, stress echo, or formal catheterization may be indicated.	**$150–2,000**
• **Psychological/psychiatric evaluation:** Even though controversial, we believe that it is extremely important to r/o active emotional disorders that will jeopardize the success of the surgery.	**$150**
• **Gastric evaluation:** In some instances it is important to r/o the presence of peptic ulcer disease. In some centers *Helicobacter pylori* testing is mandatory.	**E6D $500**
Some centers prefer to perform an esophagogastroduodenostomy (EGD) to rule peptic ulcer disease.	***H. pylori* $50**
• **Endocrine evaluation:** May be indicated in particular situations to r/o metabolic causes of obesity or aid in the management of diabetes perioperatively.	**$150–400**
• **Physical therapy evaluation:** Preoperative evaluation may help improve mobility before surgery and facilitate postoperative recovery.	**$150–300**

- **Support group participation:** In our program this is an interactive forum where postoperative patients, new candidates, and members of the bariatric team discuss issues relevant to the perioperative period and to long-term accommodation to gastric bypass. Our patients are required to attend a minimum of two meetings before they can be considered for surgery. **$20/session**

IMAGING CONSIDERATIONS

➔**Ultrasonography of the RUQ:** Cholelithiasis is prevalent in obese patients, and 30% of patients undergoing weight reduction surgery will eventually develop gallstones. Accordingly, some surgeons have recommended prophylactic cholecystectomy at the time of gastric-bypass surgery. Current data seems to support careful observation and surgical intervention only if the patients have symptoms after surgery. Ordering routine preoperative ultrasonography has fallen out favor. **$225**

Obesity Comorbidities and the Effect of Gastric Bypass

Type II Diabetes Mellitus

Pφ/TP Obesity is associated with type II diabetes. The exact pathophysiology of obesity-induced diabetes is not known, but it is thought to be related to impaired hepatic uptake of insulin, which causes a systemic hyperinsulinemia and leads to peripheral insulin resistance. An adipocytokine called "resistin" may be responsible for insulin resistance.

Tx **Potential Effect of Gastric Bypass**
Gastric bypass will generally (92%) eliminate the need for insulin in type II diabetes. **See Sabiston 17, Becker 5.**

Hypertension

Pφ/TP Obesity causes a rise in blood pressure by increasing renal tubular absorption, impairing pressure natriuresis, and promoting volume expansion due to activation of the sympathetic nervous system and the renin-angiotensin-aldosterone system.

There is no typical presentation for hypertension. Hypertension is often a silent disease until it has reached the stage where organ damage has occurred.

Potential Effect of Gastric Bypass
Hypertension is resolved in 70% of patients, and a notable decrease in medication is noticed in the majority of the remaining patients. **See Sabiston 17.**

Gastroesophageal Reflux Disease

Pφ/TP Normal symptoms of GERD are most often caused by a decreased lower esophageal sphincter pressure. The increased intra-abdominal pressures of the morbidly obese predispose to GERD.

Potential Effect of Gastric Bypass
Almost all patients experience resolution of their GERD symptoms immediately postoperatively. **See Sabiston 42, Becker 27.**

Obstructive Sleep Apnea

Pφ/TP Obesity is the most important risk factor for sleep apnea. Fat deposition around the upper airway may cause anatomic changes leading to sleep apnea. Patients have multiple episodes of apnea throughout the night due to airway obstruction at the level of the pharynx, wake up multiple times per night gasping for air, and usually complain of being tired in the morning. Most partners report a snoring issue. Tx is with continuous positive airway pressure (CPAP), which is effective, but bothersome to patients as they must sleep with a mask.

Potential Effect of Gastric Bypass
Sleep apnea improves for most patients after weight loss is achieved. **See Sabiston 17.**

Depression

Pφ/TP Obesity and depression have long been associated with each other. There are suggestions that the two are linked via the hypothalamic-pituitary axis and cortisol release. There is clearly a social element to the link: negative encounters to which obese patients are subjected contribute to depression. Poor self-image plays a role.

Potential Effect of Gastric Bypass
Depression does not immediately resolve postoperatively and it may never resolve. The support group and other counseling are meant to help patients work through the changes that are destined to occur.

Relationships will change, and not necessarily for the better. Patients must be forewarned about these issues. **See Sabiston 17.**

Osteoarthritis

Pφ/TP Osteoarthritis is the end result of mechanical "wear and tear" of joints (particularly hips and knees) and is hastened by obesity.

Potential Effect of Gastric Bypass
Joint pain is reduced in almost all patients after significant weight loss. **See Sabiston 17, Becker 42.**

Surgical Options — Medical Knowledge

Editor's note: As presented in this chapter, gastric bypass has become the gold standard of bariatric operations. It is important to understand the background and theory of other bariatric procedures developed over the past four decades, some of which are still used.

Vertical Banded Gastroplasty (***VBG***) is a restrictive procedure that creates a small pouch in the proximal stomach. There is no diversion of the food stream. The downside is that patients tend to switch to a high-caloric liquid diet, thus defeating the purpose of the VBG.

The Adjustable Laparoscopic Gastric Banding **(*Lap-Band*)** has been popular for over a decade in Europe and Australia and is gaining popularity in the United States. The procedure consists of laparoscopic placement of an adjustable band around the proximal stomach just below the GE junction to create a small pouch. Hence its physiology is the same as VBG. Two advantages of gastric banding over gastric bypass are decreased complication rates and ease of performance. Weight loss is generally less than that achieved with gastric bypass.

Bilio-pancreatic diversion **(*BPD*)** is a "malabsorptive" procedure, popularized in Europe by Scopinaro. Initially reserved for extremely obese patients with BMI > 60, the procedure includes a two-thirds gastrectomy and significant bypass of the small intestine. The added malabsorptive risk requires careful monitoring and aggressive nutritional replacement.

***Bilio-pancreatic diversion with duodenal switch* (*BPD/DS*)** is a modification of the BPD procedure. It preserves the pylorus to decrease dumping.

Jejuno-ileal bypass is of historical interest only. Popular in the 1970s, this malabsorptive procedure was largely abandoned due to the frequency of serious complications, including hepatic failure, severe malnutrition, and electrolyte imbalances. **See Sabiston 17.**

PATIENT CARE

Gastric Bypass, Postoperative Issues

Early complications:
- Anastomotic leak
- Bleeding
- Atelectasis/pneumonia
- Deep vein thrombosis (DVT) and pulmonary embolism
- Wound infection

Late complications:
- Anastomotic stricture
- Marginal ulcers
- Hernias
- Skin infections secondary to redundant skin
- Vitamin/mineral deficiencies: iron, B_{12}, calcium

Specific postoperative issues worthy of note:
- Anastomotic leak can occur within first 24 hr. A water-soluble contrast study should be obtained prior to starting liquids.
- ***Physical exam in the morbidly obese patient is unreliable. Patients may have peritonitis without the usual physical findings.***
- A structured long-term follow-up system should include nutritional assessment and vitamin checks at least once a year.

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
Bariatric surgery: A systematic review and meta-analysis

Authors
Buchwald H, Avidor Y, Braunwald E, Jensen MD, Porias W, et al.

Reference
JAMA 2005;293(14):1726

Problem
About 5% of the US population is morbidly obese. This disease remains refractory to diet and drug therapy. Can surgery help?

Intervention
None

Quality of evidence
Meta analysis of the bariatric literature in English between 1990 and 2003.

Outcome/effect
The mean percentage of excess weight loss was 61.2% for all patients. Operative mortality was 1%. Diabetes completely resolved in 77% of the patients, hypertension resolved in 61.7%. Obstructive sleep apnea resolved in 85.7%, hyperlipidemia improved in 70%.

Historical significance/comments
This is one of the landmark papers that documents the benefits of bariatric surgery in both weight loss and amelioration of medical comorbidities. The procedures were performed with an extremely low mortality rate.

Interpersonal and Communication Skills

Choosing Words: Talking about Obesity
Morbidly obese patients have emotional issues related to their weight due to years of the negative encounters they have endured. Understanding and acceptance are particularly important, and you should set aside extended time to allow patients to talk about these nonmedical aspects of obesity.

Choose words wisely: Asking a patient, “How long have you been this fat?” is inappropriate. Instead, you should ask, “How long have you had a problem with your weight?” This sensitivity should be ubiquitous: office staff, students, residents, and physicians should also be cognizant of language selection and the need for emotional sensitivity.

Professionalism

Principle of Social Justice
Obese patients are often neglected and mistreated by parts of society, and the health-care arena is not an exception. In one study, 50% of primary care physicians viewed obese patients as “awkward, unattractive, ugly, and noncompliant.”[1] Conversely, 75% of obese patients have minimal expectations that their doctors will “do something” for their obesity problem. A radical change in our profession’s perception of obesity must take place. We need to recognize obesity as a disease and have effective mechanisms in place to provide proper care.

Very few health-care facilities have adequate equipment to treat and manage obese patients. Most radiology equipment, for example, holds only up to 350 lb. Most hospital stretchers, wheelchairs, and beds have even lower capacity. Regardless of whether a facility is a designated “bariatric center” or not, institutions need to be better equipped to provide care to obese patients.

Obesity is responsible for a large number of patients on disability. Bariatric surgery has the potential to restore these patients to a productive life in society. Physicians have a responsibility to become advocates for these patients.

Systems-Based Practice

Public Health Intervention and Working with Payers

The rapid acceptance of gastric bypass surgery as a viable option for long-term weight control has created a dramatic increase in the number of bariatric surgeries performed in the United States, from approximately 10,000 surgeries per year to more than 150,000 surgeries in 2006. This has resulted in an increase in the cost to insurance companies and an increase in the number of less experienced surgeons performing the procedure, with a concomitant increase in the rate of complications. As a result, insurance companies have restricted procedure access and reimbursement and professional societies have established training guidelines for bariatric procedures. In 2004 Blue Cross in Florida announced that it would no longer cover these procedures (which cost from $20,000 to $35,000) as of January 2005. In 2005 the American Society for Bariatric Surgery launched its “Center of Excellence Program” to standardize the quality and practice of bariatric surgery, and a similar initiative was undertaken by the American College of Surgeons.

Reference

1. Foster GD, Wadden TA, Makris AP, Davidson D, Sanderson RS, Allison DB, and Kessler A: Primary care physicians’ attitudes about obesity and its treatment. Obesity Res 2003;11:1168–1177.

Have you had the opportunity to evaluate an obese patient, considering a bariatric procedure? Consider reviewing your patient interaction in the context of the Competency Self-Assessment Form on page 35, which can also be found as a Word document on the book’s Web site at www.studentconsult.com.

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Chapter 58
Coronary Revascularization (Case 40)

Sharon Ben-Or MD *and Francis D. Ferdinand* MD

Cases Considered

Patient 1 67-year-old male with acute MI

Patient 2 61-year-old female with exertional chest pain

Speaking Intelligently

By the time patients with an acute MI, exertional chest pain, or an abnormal stress test are referred to a cardiac surgeon, most have already had a workup for ischemia including a ***stress test*** and ***cardiac catheterization***. Nonetheless, when a patient is sent to me for consideration of coronary revascularization, I take my own careful hx in order to categorize the patient's symptoms in terms of the New York Heart Association functional class categories.

A patient's workup must determine the location and extent of the lesions within the coronary vessels as well as any concomitant valvular lesions or arrhythmias that might need to be addressed at the time of surgery. Assessing the patient's comorbidities is key in planning for surgery and assessing risk. I always evaluate for peripheral vascular occlusive disease, cerebrovascular disease, renal insufficiency, and diabetes.

PATIENT CARE

Clinical Thinking

- **Patient 1:** In the setting of acute chest pain, an EKG is key for evaluating ST segment elevation as well as localization of the lesion and determination of associated arrhythmia.
    - In the acute setting, cardiac catheterization is indicated in order to demonstrate the location of the lesion and other areas of stenosis, open the diseased artery, and prevent irreversible cardiac damage.

  - It is recommended to stabilize the patient for a period of 72 hr prior to operating.
- **Patients 1 and 2:** Cardiac catheterization defines the anatomy and enables planning for stenting or bypass.
  - Echocardiography defines valvular lesions that may occur concomitantly with coronary artery disease.

History

- Determine duration and character of the symptoms: location, radiation, and characteristic of pain; associated nausea and vomiting; diaphoresis; and palpitations.
- What worsens the pain? Consider exercise and stress. What alleviates the symptoms? Consider rest, nitroglycerin, and anxiolytics.
- Have symptoms worsened over time?
- Determine if there is a previous hx of coronary artery disease, peripheral vascular disease, renal insufficiency, and cerebrovascular disease.
- A family hx of cardiac disease should also be elicited.

Physical Examination

- Auscultate the carotid arteries for bruits.
- Auscultate the lungs for rales.
- Cardiac examination should be focused on whether the rate and rhythm are regular; determine presence of murmurs, rubs, or gallops.
- Examine for peripheral pulses.
- Particular attention should be paid to the ***Allen's test*** on both arms as the radial artery is a potential conduit for bypass. The Allen's test involves occluding both the radial and ulnar arteries while the patient is making a fist and then releasing the ulnar artery to see if it is adequate as the only blood supply to the hand.

Tests for Consideration

- **CBC:** Platelets, hemoglobin, and white count. **$35**
- **Lipid profile:** Total cholesterol, HDL, LDL, and triglycerides. Higher LDL levels are correlated with progression of lesions, and HDL with long-term survival. **$65**
- **BMP:** Potassium, BUN, creatinine, sodium, glucose, bicarbonate, and chloride. **$45**
- **Hemoglobin A1C:** The level of hemoglobin A1C is increased in the RBCs of patients with poorly controlled diabetes mellitus. Since the glucose stays attached to hemoglobin for the life of the RBC (normally about 120 days), the level of hemoglobin A1C reflects the average blood glucose level over the past 4 months. **$43**
- **Stress test:** The patient's heart is "stressed" by exercise or stressed pharmacologically to illicit EKG, echocardiography, or perfusion images indicative of ischemia. **$465**

IMAGING CONSIDERATIONS

➔**Echocardiography:** Preoperative ultrasound evaluation of cardiac valves and wall motion is essential for operative planning. Unsuspected aortic stenosis, ventricular aneurysm, or severe aortic atherosclerosis may drastically alter the therapeutic approach. **$325**

➔**Cardiac catheterization:** Angiography of the coronary arteries to define coronary anatomy, the extent of the lesion(s), and possible percutaneous intervention. **$2,000**

➔**Coronary CT angiography:** Noninvasive CT requires ultra-fast multidetector scanners and cardiac gating to create 3D images of the heart and coronary arteries. Until technical obstacles are overcome, this study is considered experimental. **$875**

➔**Carotid Doppler:** Preoperative ultrasound screening of the carotid arteries is controversial, but the association between coronary and carotid atherosclerosis remains a consideration in the prevention of stroke. **$275**

Clinical Entities — Medical Knowledge

Coronary Insufficiency

Pφ The pathogenesis of coronary artery disease is the development of atherosclerotic plaque over several decades from a fatty streak to a lesion that narrows the vessel. When plaque ruptures or if there is intraplaque hemorrhage, acute closure of the vessel occurs.

Patient 1

TP Patients in the process of an evolving MI present with the feeling of “an elephant sitting on [one’s] chest.” Symptoms may be accompanied by nausea, vomiting, diaphoresis, dyspnea, and, sometimes, loss of consciousness.

Dx In the setting of an acute MI, the EKG will show ST segment changes in the corresponding anatomic lead. Cardiac enzymes in the acute setting will show elevated CK-MB and troponin. In this situation, a cardiac catheterization can be both diagnostic and therapeutic.

Tx During acute coronary syndrome the patient should be given aspirin, IV beta-blockers, and IV nitroglycerin, and the ACLS protocol should be followed as needed. Determine if the patient can be reperfused using thrombolytics or percutaneous coronary intervention. Studies have shown that stabilization of patients for 72 hr prior to revascularization lowers the surgical risks.

Patient 2

TP Patients with angina typically present with chest pain radiating in their left arm or jaw on exertion. However, there are many atypical presentations of angina. Patients may present with fatigue or shortness of breath or may even be completely asymptomatic.

Dx Abnormal stress tests will show focal areas of decreased uptake/ ischemia both for the patient with angina and the patient whose insufficiency is discovered by the surveillance stress test.

Tx For lesions ***not*** involving the left main or proximal left anterior descending artery, coronary artery bypass grafting (CABG) or angioplasty and stenting can be used. **In general, there is a better long-term outcome with CABG when the lesions are more proximal and when there are greater numbers of vessels affected.** In chronic situations, the decision between surgical, medical, and percutaneous coronary interventions should be discussed among the surgeon, cardiologist, and patient. The general guidelines for CABG include patients with one or more of the following: left main involvement, lesion of the proximal left anterior descending artery, greater than two diseased vessels, treated diabetics, and those with decreased left ventricular function. In these instances, CABG is more cost effective and leads to better long-term outcomes. **See Sabiston 61, Becker 29.**

ZEBRA ZONE

a. **"Silent ischemia":** Many patients (especially diabetics) may have "silent ischemia," where they do not have typical "textbook" angina symptoms. They may exhibit no pain, shortness of breath/dyspnea, GERD-like symptoms, or atypically located pain (e.g., jaw).

b. **Coronary spasm, secondary to Printzmetal angina or cocaine use:** Usually at or near a site of atherosclerosis, coronary spasm may mimic acute coronary syndrome. This is not an MI but may predict cardiac disease to come.

c. **Aortic stenosis:** May present with angina due to decreased blood flow in the coronary arteries. **See Becker 29.**

d. **Aortic Dissection:** May present with angina if the dissection involves the coronary arteries or due to the sudden expansion of the aorta itself. **See Sabiston 62, 63; Becker 29.**

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
Long-term outcomes of coronary-artery bypass grafting versus stent implantation

Authors
Hannan EL, Racz MJ, Walford G, Jones RH, Ryan TJ, Bennet E, Culliford AT, Isom OW, Gold JP, Rose EA

Institution
Multi-institutional study

Reference
New England Journal of Medicine 1995;352(21):2174–2183

Problem
Does CABG have better long-term outcomes than stent implantation?

Intervention
None

Quality of evidence
Retrospective analysis of New York's cardiac registries of 37,212 patients undergoing CABG and 22,102 undergoing stent placement

Outcome/effect
8% of patients stented initially required CABG and 27% required repeat stenting, whereas 0.3% of patients who underwent CABG initially required repeat CABG and only 5% required stenting. This study suggests that CABG is superior to stent placement for patients with coronary artery disease involving two or more vessels in providing higher adjusted rates of survival and vessel patency.

Historical significance/comments
At the time of this study, coronary artery stent placement had become the standard for coronary artery disease. These data provide strong evidence for CABG, particularly in those patients with multivessel disease.

Interpersonal and Communication Skills

Communication with the Team
The cardiac surgeon must interface well with several multidisciplinary teams. The OR team includes the surgical assistants, nurses, perfusionist, and anesthesiologist. The ICU team is responsible for the recovery process, and the third multidisciplinary team includes social workers, physical therapists, and nutritionists who help patients modify lifestyles and preoperative risk factors in order to prevent recurrence and/or progression of disease following surgery.

Here are a few tips for developing better communication among your health-care teams:

- Listen.
- Respect the opinions of others.
- Try to understand another's perspective.
- Don't take things personally.
- Cooperate and assume your colleague is acting in good faith.
- Don't be judgmental.
- Learn to compromise.
- Seek a diplomatic approach to conflict resolution.
- Learn to admit when you are wrong.

Professionalism

Commitment to Professional Responsibilities: Is the "Surgical Personality" dangerous?

Although it is misnamed and overly specified, a surgical personality exists. Its features include wielding authority in an overbearing way and treating subordinates in a psychologically abusive manner. Individuals in positions of authority who misuse authority to humiliate those under their control are not in short supply in any workplace. As with most clichés and stereotypes, more surgeons probably behave this way than other physicians; however, there is no shortage of the "surgical personality" among physicians in all specialties.

To Err Is Human: Designing a Safer Health Care System, the Institute of Medicine's seminal report on the prevalence of preventable adverse events in medicine, identified dysfunctional responses to error and criticism among physicians, characterizing these ("the naming, blaming, and shaming" individuals[1]) as inhibitions to the sharing of knowledge that would serve to prevent mistakes being repeated. To decrease preventable mistakes, the "surgical personality" needs to be more receptive to constructive criticism and feedback.[2]

Systems-Based Practice

Standardization of Clinical Practice: Clinical Pathways

Important for the success of a cardiac surgery program is patient care built on protocols or *clinical pathways*, which enable everyone on the team to know every step in a patient's preoperative, operative, and postoperative care. Here are several examples of care issues that are standardized for all patients at our institution whose care is identified as routine:

- During preoperative testing, the cardiologist, anesthesiologist, and surgeon work to minimize the risk of surgery by improving the patient's nutritional status, fluid balance for any renal insufficiency, beta-blockade and statins for their cardioprotective effects, and educating the patient and his or her family about the recovery process.
- There is *one* surgical prep and antibiotic protocol for *all* patients and the results are diligently tracked.
- Approximately 75% of the patients are extubated in the OR and mobilized out of bed immediately postoperatively to improve pulmonary recovery. The Foley catheter is removed on POD #1 provided that urine output is adequate. Small (Blake) chest drains are used to allow ambulation.
- Once a patient is stable (usually <24 hr postsurgery), he or she is transferred to a cardiac floor where nurses, physical therapists, and nutritionists work together under the supervision of the surgeon to hasten the recovery process.
- All patient data are prospectively entered into a Society of Thoracic Surgeons–compatible database for reviewing quality control and outcomes.

References

1. Kohn LT, Corrigan JM, and Donaldson MS: To Err Is Human: Designing a Safer Health Care System. Washington, DC: National Academy Press, 2000.
2. Bosk CL: Is the "Surgical Personality" a Threat to Patient Safety? Spotlight Case. WebM&M, April 2006. http://www.ahrq.gov

Chapter 59
Teaching Visual: Coronary Bypass

Sharon Ben-Or MD *and Francis P. Sutter* DO

Objectives

- Draw the essential coronary anatomy.
- Explain the internal mammary artery (IMA) and aortocoronary conduits to your patient.

Medical Knowledge

The evaluation of the coronary angiogram is key to the planning of the surgery. The surgeon must visualize the location and extent of the lesions in order to determine how many grafts are needed.

Note the important vessels in Figure 59-1: right, left main, LAD, and left circumflex. The right (~85%), circumflex (~10%), or both (~5%) give off the posterior descending artery.

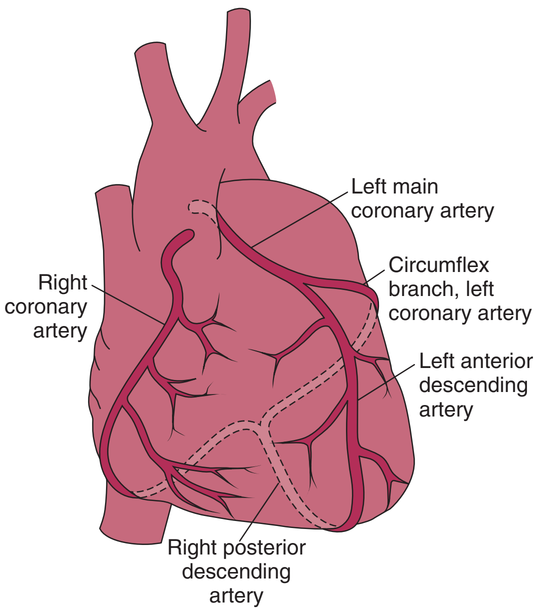

Figure 59-1

The gold standard conduit for left anterior descending (LAD) disease is the left IMA. The saphenous vein and the radial artery can also be used as conduits. The right IMA can be used as a graft to the right coronary artery. In poorly controlled or obese diabetic patients, simultaneous use of both IMAs is usually avoided due to a greater risk for sternal wound infections.

The IMA, which runs along the inside edge of the sternum, is remarkably resistant to atherosclerosis. The IMA is conveniently located near the most important coronary branch, the LAD, allowing transfer of the distal end of the IMA to the LAD after mobilizing the entire length of the IMA (Fig. 59-2).

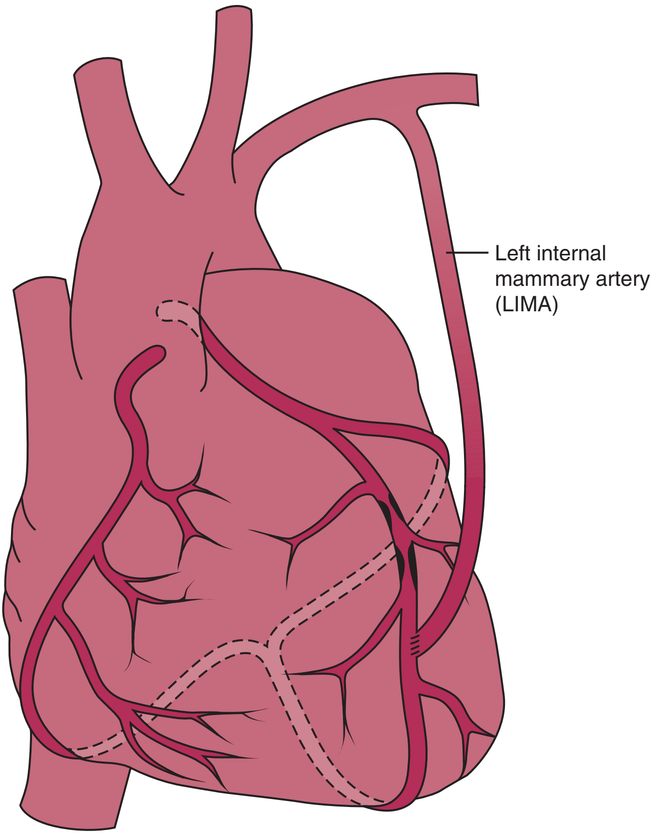

Figure 59-2

The greater saphenous vein is easy to harvest (by open technique or endoscopically) and is usually long enough to be used for several grafts. It is larger in caliber than the IMA, making surgery technically easier. It requires both a proximal (to the aorta) and distal anastomosis (Fig. 59-3).

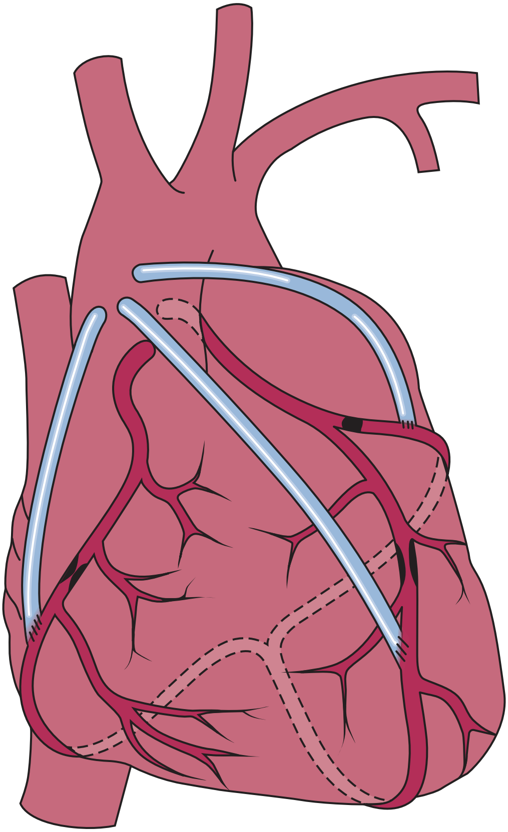

Figure 59-3

In Figure 59-4, complete the dotted lines to form the following vessels and their anastomoses with each other: right coronary artery, left coronary artery, circumflex, LAD, and posterior descending artery.

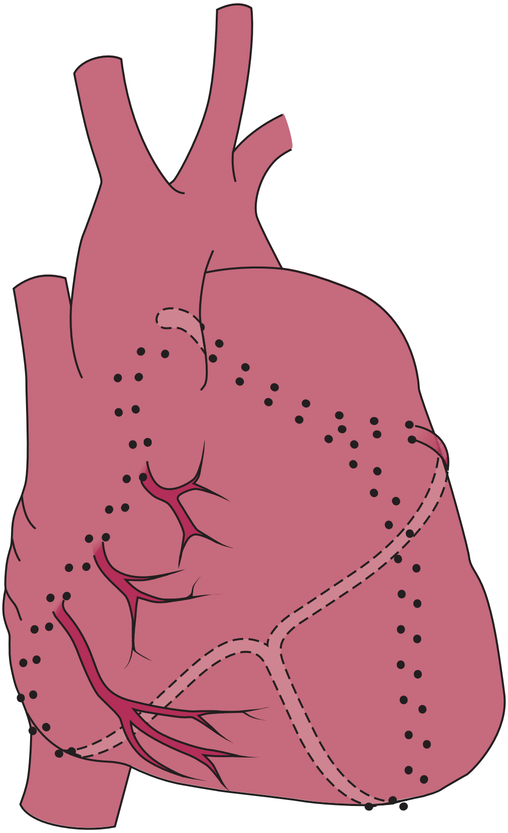

Figure 59-4

Interpersonal and Communication Skills

Teach Your Patient

In Figure 59-5, there are significant stenoses of the right coronary artery, left circumflex, and LAD. Connect the dots to explain the following to your patient:

1. The use of the left IMA to revascularize the LAD
2. The use of saphenous vein aortocoronary bypass grafts to bypass the stenoses in the right coronary and left circumflex vessels

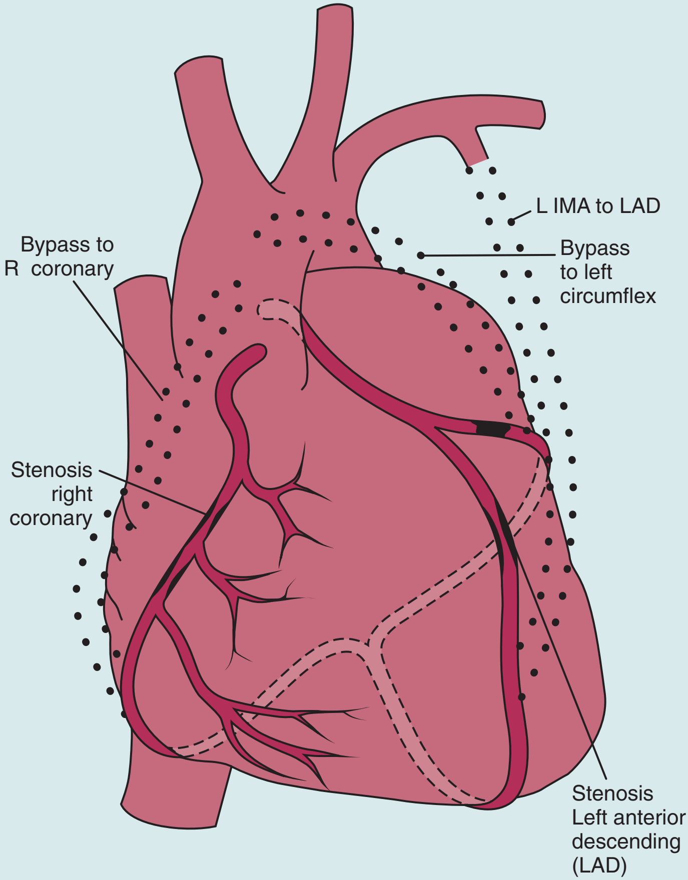

Figure 59-5

Chapter 60
Mediastinal Mass in a 61-Year-Old Male (Case 41)

Douglas E. Paull MD

Differential Diagnosis

Thymoma	Lymphoma	Neurogenic tumor
Bronchogenic cyst	Substernal goiter	Germ cell tumor

Speaking Intelligently

When I'm asked to see a patient with a mediastinal mass, I immediately answer three questions: (1) the patient's age; (2) whether the patient is symptomatic or not; and (3) whether the location of the abnormality is in the anterior, middle, or posterior mediastinal compartment.

The **anterior mediastinal compartment** (extending from the thoracic inlet to the diaphragm in a superior-inferior direction, and from the sternum to the anterior surface of the pericardium in an anterior-posterior direction) includes the thymus, lymph nodes, and brachiocephalic vessels. The **middle mediastinum** contains the heart/great vessels, trachea, lymph nodes, and phrenic nerves. **The posterior mediastinum** (bounded by the ribs and vertebrae posteriorly, the posterior surface of the heart anteriorly, and the diaphragm inferiorly) contains nerve roots, the sympathetic chain, the vagi, esophagus, descending aorta, and thoracic duct.

Knowing the age of the patient and the location of the mediastinal lesion narrows the diagnostic possibilities, permits a cost-effective workup, and allows for accurate and timely recommendations/tx.

PATIENT CARE

Clinical Thinking

- Anterior mediastinal masses comprise the "4 T's": *thymoma*, ("*terrible*") ***lymphoma***, *teratoma* (germ cell tumors), and *thyroid* (substernal goiter).
- Middle mediastinal masses include *lymphoma* and *bronchogenic cysts*.
- Posterior mediastinal masses consist primarily of ***neurogenic*** tumors.
- The presence of symptoms and the incidence of malignancy are higher in children than adults. For example, a symptomatic child with a posterior mediastinal mass is likely to have a malignant neuroblastoma, whereas an asymptomatic adult with a posterior mediastinal mass would be more likely to have a benign neurolemmoma (schwannoma).

History

- Patients with **thymoma** may complain of symptoms due to local mass effects (chest pain, dyspnea, or cough). In addition, patients may suffer from symptoms due to autoimmune disorders that may accompany thymoma; for example, myasthenia gravis with muscular weakness.
- In addition to local mass effect symptoms, patients with **lymphoma** may complain of fevers, night sweats, or weight loss.
- Many **neurogenic tumors** are incidental findings on routine chest radiography; pheochromocytoma leads to symptoms of catecholamine overproduction (hypertension, palpitations, and headaches).
- The majority of **bronchogenic cysts** are asymptomatic; patients may, however, complain of chest pain, cough, dyspnea, and occasionally stridor.
- Patients with **substernal goiter** may exhibit symptoms related to tracheal (wheezing, dyspnea) or esophageal compression (dysphagia). Rarely, the presenting symptom is thyrotoxicosis.
- Symptoms are frequent among patients with malignant **germ cell tumors** and include chest pain, dyspnea, weight loss, and superior vena cava (SVC) syndrome (headache, arm swelling). Although rare, the coughing up of hair or sebaceous material is pathognomonic for a benign germ cell tumor (teratoma) eroding into the tracheobronchial tree.

Physical Examination

- Any of the mediastinal masses may cause the *SVC syndrome*. Patients demonstrate edema and cyanosis of the head, neck, and extremities.
- **Thymoma** patients who have associated myasthenia gravis may demonstrate cranial nerve muscular weakness, including ptosis and diplopia.
- Patients with **lymphoma** may have palpable lymphadenopathy or splenomegaly.
- A **neurogenic tumor** involving the sympathetic chain and the stellate ganglion may produce Horner's syndrome with ipsilateral ptosis, miosis, and anhydrosis.
- A palpable cervical goiter is often present in patients with **substernal goiter**.
- A testicular mass in a male patient with a mediastinal mass may be indicative of metastatic **germ cell tumor**.

Tests for Consideration

- **Mediastinoscopy:** Evaluates lymphadenopathy in the middle mediastinum (e.g., lymphoma vs. sarcoid). Routine staging procedure for patients with lung cancer with possible mediastinal node metastases. **$414**
- **Thoracoscopy (video-assisted thoracoscopic surgery [VATS]):** Increasingly being utilized not only to diagnose, but also to resect carefully selected mediastinal masses. **$481**

IMAGING CONSIDERATIONS

➔**CXR (PA and lateral erect):** Initial imaging examination. A useful preoperative overall evaluation of the entire thoracic cage to delineate size and extent of disease. **$327**

➔**CT of the chest with contrast:** Provides accurate evaluation of mediastinal anatomy, size and extent of tumor, as well as benign and malignant characteristics (e.g., invasion of adjacent structures, calcifications, and cystic characteristics). **$950**

➔**MRI:** Useful in the evaluation of posterior mediastinal masses to evaluate neurogenic origins or invasion. MRI gadolinium contrast is optional. Cardiac gating MRI is valuable in the evaluation of cardiac or vascular invasion. **$1,428**

Clinical Entities — Medical Knowledge

Thymoma

Pφ ***Thymoma*** is the most common tumor in the anterior mediastinum and accounts for 19% of all mediastinal masses. There are several histologic subtypes: epithelial, spindle cell, lymphocytic, and mixed. Associated clinical syndromes include myasthenia gravis (30%–60% of patients) and red cell aplasia (5% of patients).

TP The typical patient is an adult. Half of the patients are asymptomatic, the other half have chest pain, dyspnea, or SVC syndrome.

Dx In selected patients, the tumor is simply resected without preoperative tissue dx. In patients with either more advanced disease or uncertain dx, either a CT-guided needle biopsy, VATS, or Chamberlain procedure (anterior mediastinotomy) can be utilized to obtain a biopsy specimen, albeit at the risk of "seeding" the tract.

Tx Tx is complete surgical resection, usually via median sternotomy, whenever possible. Stage I (no capsular invasion) is adequately treated by resection alone. Stage II (invasion of surrounding fat) and stage III (invasion of surrounding structure, e.g., pericardium) are treated with complete resection followed by radiation. Patients with stage IV (metastasis) receive platinum based chemotherapy. Ten year-survival for thymoma by stage is I, 86%; II, 75%; III, 58%; and IV, 40%. **See Sabiston 58, Becker 28.**

Lymphoma

Pφ ***Lymphomas*** represent 13% of mediastinal masses and are classified as either Hodgkin's lymphoma (characteristic Reed-Sternberg cell) or non-Hodgkin's lymphoma. Nodular sclerosing is the most common type of Hodgkin's lymphoma in the mediastinum.

TP The mediastinum is usually not the only site of disease in patients with lymphoma. Patients may present with constitutional symptoms such as fever and weight loss, as well as symptoms due to local mass effects (chest pain, dyspnea, SVC syndrome). Patients may be asymptomatic. The typical Hodgkin's lymphoma patient is a young adult who has associated cervical lymphadenopathy. Non-Hodgkin's lymphoma is more aggressive and patients are more likely symptomatic. Non-Hodgkin's lymphomas of the mediastinum include lymphoblastic lymphoma (children) or large cell lymphoma (adults).

Dx Unlike the CT appearance of thymoma (solitary mass), lymphoma presents as multiple nodules consisting of lymph nodes. Core needle biopsy may not be successful in establishing a histologic dx. When needle biopsy is not possible or the results are nondiagnostic, a Chamberlain procedure (anterior mediastinotomy) or VATS will establish the dx.

Tx Tx of Hodgkin's lymphoma is by stage (Ann Arbor) of disease, but consists primarily of multiagent chemotherapy and irradiation. **See Sabiston 58, Becker 28.**

Neurogenic Tumors

Pφ ***Neurogenic tumors*** usually occur in the posterior mediastinum and make up 20% of all mediastinal masses. Tumors may originate from nerve sheath (neurolemmoma = Schwannoma), autonomic nerves (neuroblastoma), or the paraganglionic system (pheochromocytoma). Most neurogenic tumors in adults are benign (neurolemmoma), whereas in children malignancy (neuroblastoma) is common.

TP The typical adult is asymptomatic, with a posterior mediastinal mass disclosed on a routine chest radiograph. Children with neuroblastoma often present with metastatic disease, spinal cord compression, and/or paraneoplastic syndromes.

Dx For the typical reasonably healthy adult with an otherwise resectable posterior mediastinal mass that is not invading the spinal canal ("dumb-bell" tumor), resection via VATS or thoracotomy is both diagnostic and therapeutic. Patients with suspected pheochromocytoma (hypertension, etc.) should undergo confirmation with metanephrines and vanillylmandelic acid (VMA) tests and preoperative alpha-blockade.

Tx Patients with dumb-bell tumors require neurosurgical consultation and laminectomy combined with thoracotomy. Tx of children with neuroblastoma is related to stage of disease and may include surgery (excision, debulking, and/or second look), radiation, and chemotherapy. **See Sabiston 58, Becker 28.**

Bronchogenic Cyst

Pφ ***Bronchogenic cysts*** are sequestrations of the foregut, the embryologic precursor to the tracheobronchial tree. The cyst wall is lined by respiratory epithelium. They are usually located near the carina in the middle mediastinum and when combined with other cysts (pericardial, enteric duplication) account for 18% of all mediastinal masses.

TP The typical patient is an asymptomatic adult with an abnormality found on routine chest radiography. Children are more likely to demonstrate compressive symptoms.

Dx Dx can usually be made by the characteristic CT (water attenuation) or MRI (increased signal intensity on T2-weighted images) appearance of a smooth-walled cystic density at the level of the carina.

Tx In otherwise healthy patients, surgical excision is indicated to prevent complications (primarily infection). This can be accomplished by thoracotomy or VATS. **See Sabiston 58; Becker 28, 56.**

Substernal Goiter

Pφ ***Substernal goiter*** represents the mediastinal extension from a cervical thyroid goiter. Endocrine tumors, of which substernal goiter is the most common, make up 6% of mediastinal masses.

TP The typical patient is a female (3 : 1 predominance) in the sixth to seventh decade of life, who is asymptomatic with a palpable cervical goiter. Symptoms, when present, include dyspnea and dysphagia.

Dx Dx is usually apparent by CT demonstrating a heterogeneous, multilobulated, and encapsulated mediastinal mass in continuity with the cervical thyroid.

Tx Symptomatic substernal goiters should be resected. Since the blood supply originates in the neck, the majority of lesions can be removed with a cervical collar incision. Larger goiters may require a limited or full sternotomy. **See Sabiston 58, Becker 28.**

Germ Cell Tumor

Pφ ***Germ cell tumors*** originate from primordial urogenital ridge cell rests in the mediastinum. They may be benign (teratoma) or malignant (seminoma or nonseminomatous). Nonseminomatous germ cell tumors include embryonal cell carcinomas, choriocarcinomas, and endodermal cell tumors. Germ cell tumors make up 10% of mediastinal masses.

TP The typical patient with a malignant mediastinal germ cell tumor is a male in the third to fourth decade of life, with chest pain, cough, dyspnea, and weight loss. There is no gender predilection in patients with teratoma.

Dx CT in patients with malignant nonseminomatous germ cell tumors demonstrate a large bulky heterogeneous (areas of necrosis) mass in the anterior mediastinum compressing adjacent structures. Elevated serum levels of α-fetoprotein and β-hCG are diagnostic of malignant nonseminomatous germ cell tumors (e.g., embryonal cell carcinoma). CT in patients with seminoma shows a bulky homogeneous mass which usually does not invade adjacent structures. Seminoma patients usually have negative serology. Histologic dx of seminoma may require needle biopsy, Chamberlain procedure (anterior mediastinotomy), or VATS. CT in a patient with teratoma demonstrates a well defined, smooth, lobulated mass with fat and calcium. The dx of benign teratoma is confirmed upon its resection.

Tx Teratomas are resected via median sternotomy. Nonseminomatous germ cell tumors are treated with cisplatin and etoposide-based chemotherapy. Serum markers are followed for response to therapy. Patients who have both a complete serologic and radiographic response are followed closely. Patients whose markers normalize, but have residual radiographic disease, undergo surgical resection. Overall, the 5-year survival rate is 45%. Seminomas are treated with radiation and/or chemotherapy and have an 88% 5-year survival rate. **See Sabiston 58, Becker 28.**

ZEBRA ZONE

a. **Giant cell lymph node hyperplasia (Castleman's Disease):** May present as tumors anywhere in the mediastinum. Most common histologic type demonstrates hylanized follicles with capillary proliferation. **See Sabiston 58.**

b. **Extramedullary hematopoiesis:** Bilateral paravertebral masses in the posterior mediastinum seen in patients with myelofibrosis or thalassemia. ^{99m}Tc sulfur colloid scanning is diagnostic. **See Sabiston 58.**

c. **Mediastinal neuroendocrine tumors (carcinoids):** Arise from Kulchitsky cells in the thymus. Usual patient is male 40 to 50 years of age. Aggressive tumors. Many are hormonally active, producing ACTH (Cushing's syndrome). **See Sabiston 58.**

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
Prognostic factors and long-term results after thymoma resection: A series of 307 patients

Authors
Regnard JF, Magdeleinat P, Dromer C, Dulmet E, De Montpreville V, Levi J, Levasseur P

Reference
Journal of Thoracic and Cardiovascular Surgery 1996;112:376–384.

Problem
The prognostic factors for thymoma have been difficult to establish because it is an uncommon tumor, tends to grow slowly, and is anatomically and histologically polymorphic. A study was needed that followed a large number of patients over a long period of time.

Intervention
None

Quality of evidence
Retrospective review of 307 patients

Outcome/effect
In a multivariate analysis, completeness of resection was the sole significant prognostic factor. The 10-year survival rate among patients with complete resection was 76% versus 28% for those undergoing an incomplete resection.

Historical significance/comments

Although it is difficult to perform randomized control studies for a relatively uncommon disease such as thymoma, this large study establishes that a complete surgical resection is the single most powerful determinant of prognosis in patients with thymoma.

Interpersonal and Communication Skills

Preoperative Preparation

A patient who has myasthenia gravis and an anterior mediastinal mass (thymoma) may require long-term intubation after surgery. First, I listen to the concerns voiced by the patient and family members. I reassure the patient that with preoperative preparation with plasmapheresis and intraoperative avoidance of neuromuscular blocking agents, the vast majority of myasthenic patients will be extubated immediately following the operation. I discuss with the patient and family the care of a patient on prolonged mechanical support (sedation, ventilator-associated pneumonia, possible tracheostomy) so that they are better prepared for this possible, but unlikely, event.

Professionalism

Commitment to Maintaining Appropriate Relations with Patients

An adult, coherent patient with a mediastinal mass is a Jehovah's Witness and refuses blood transfusions. The operation may require blood. Although Jehovah's Witness patients do not accept blood transfusions, the restriction is primarily in the use of allogeneic blood and autologous blood when separated from the body for a period of time. These restrictions usually do not prevent intraoperative blood salvage and reinfusion using a dedicated, closed circuit (the "cell saver"). Likewise, the perioperative use of erythropoietin, which contains a small amount of albumin, is often acceptable. Informed consent from a Jehovah's Witness includes a discussion of the potential of life-threatening hemorrhage and its consequences. All discussions should be meticulously documented. When questions remain, the surgeon may call the Jehovah's Witness Liaison Committee for further guidance. If the surgeon is uncomfortable with the challenges presented by the patient's needs, the patient should be transferred to a Center for Bloodless Surgery. Of course, this discussion would be far more involved for an incompetent or unconscious adult, or a child requiring an operation with more of a potential for life-threatening hemorrhage (e.g., cardiac operation).

Systems-Based Practice

Reimbursement: Coverage of New and Experimental Procedures
What would you do in a case where you would like to offer a new service to a patient with a mediastinal mass (e.g., endoscopic ultrasonography with aspiration of a mediastinal cyst), but the insurance carrier denies this tx? There are effective strategies for overturning the denial of therapy by an insurance carrier. A physician should send a letter of medical necessity and all accompanying medical records (pathology report, operative reports) to the health plan. New or investigational procedures may be covered if the physician's letter includes two articles from established medical journals that specify the benefits of the proposed procedure. A health plan may consider paying for an item not usually covered by its policy in order to avoid a more expensive option. In the example above, if the patient were elderly and frail with a symptomatic mediastinal cyst, one could make a case for patient survival and shorter length of stay after a bronchoscopic intervention under conscious sedation versus a VATS or thoracotomy requiring general anesthesia with a potentially prolonged postoperative course.

Chapter 61
Solitary Pulmonary Nodule in a 58-Year-Old Male (Case 42)

Dennis F. Zagrodnik II MD

Differential Diagnosis

Non–small cell cancer	Small cell cancer	Granuloma	Congenital lesion	Metastasis

Speaking Intelligently

When I'm asked to see a 58-year-old male who presents with a solitary pulmonary nodule, my careful history will usually help me know how to proceed with the workup. I ask if the abnormality was found during a routine screening chest x-ray or if the patient has symptoms of cough, hemoptysis, or recent pneumonia. I determine if the patient is a smoker or previous smoker and if he has had any occupational exposures, has traveled recently, has had exposure to tuberculosis, or carries a diagnosis of previous malignancy. Lastly, I ask if he has ever been told that he has a nodule in his lung or if he has had previous chest x-rays or CT scans of his chest that could help establish the duration of his nodule's existence.

PATIENT CARE

Clinical Thinking

- Keep in mind that age greater than 50 years, male gender, and a history of smoking increase the probability of lung cancer; however, lung cancer now ranks as the leading cause of cancer-related mortality in both men and women.
- As you proceed with the examination, remember that the clinical hx along with the radiological appearance will help you determine the probability of malignancy. As the average 5-year survival for all lung cancer is a dismal 5% to 10%, remember it is only the patient who is diagnosed early with a stage I cancer who can benefit from the 60–70% 5-year survival rate for stage I disease.

History

- Consider why the patient was found to have an SPN—screening CXR, infectious symptoms, or preoperative evaluation.
- Inquire about smoking hx; risk increases for duration and quantity.
- Inquire about occupational exposures, specifically asbestos, heavy metals, radon, or dust.
- Travel hx or previous habitation is important for fungal exposures like coccidioidomycosis in the Southwest or histoplasmosis in the Midwest. Foreign travel or any tuberculosis exposures are also important.
- Most SPNs are usually clinically silent without pain or physical findings. ***Non–small cell cancer and small cell cancer*** may present with hemoptysis, dry cough, or even chest pain, if pleural based. Most commonly, patients have nonspecific symptoms of fatigue and weight loss if any symptoms at all. ***Granulomas*** are usually preceded by some acute infectious symptoms of fever, cough, and malaise, which may have occurred several years earlier. ***Congenital lesions*** are usually asymptomatic unless secondarily infected. ***Metastases*** are also asymptomatic unless associated with other sites of recurrence.

Physical Examination

- ***Physical examination rarely gives insight to the etiology of an SPN.*** However, the examination should focus on several things: search for potential spread of metastatic lung cancer; thorough examination for comorbid or congenital disease, and examination for signs of an asymptomatic extrathoracic primary malignancy.
- Pulmonary function testing and functional status should be assessed in all patients.
- The search for spread of a metastatic lung cancer involves examination of the cervical region and supraclavicular lymph nodes. Musculoskelatal examination should look for bone tenderness, soft tissue masses, clubbing, or hypertrophic osteoarthropathy, which may suggest a paraneoplastic syndrome (most common with small cell cancer). A focused neurological examination should be performed for potential CNS metastasis or a neurological paraneoplastic syndrome.
- Abdominal masses, breast masses, abnormal skin lesions (melanoma), or soft tissue masses (sarcoma) and, in males, testicular masses (germ cell tumor) may diagnose an asymptomatic extrathoracic malignancy with single pulmonary metastasis.
- A simple test to gauge pulmonary reserve: ask the patient to walk up several flights of stairs; upon completion, see if the patient can speak in full sentences.

Tests for Consideration

- **Pulmonary function test (PFT) with arterial blood gas (ABG):** Necessary to establish tolerance for operative biopsy. **$26**
- **Fiberoptic bronchoscopy with biopsy:** Flexible lighted scope under conscious sedation sometimes with fluoroscopic assistance. May help r/o synchronous airway lesions; diagnostic yield lower for peripheral nodules and small size nodules. Diagnostic only, and a nonmalignant pathology finding is inconclusive. **$401**
- **Transthoracic needle biopsy:** CT-guided biopsy fine-needle aspiration or core needle. Risk for pneumothorax 20%. Higher risk in patients with coagulopathy and emphysematous changes. Diagnostic only and nonmalignant dx not definitive. **$950**
- **Video-assisted thoracic surgery (VATS) or open biopsy:** Necessary when bronchoscopy or image-guided biopsy is nondiagnostic and imaging/risk factors make malignancy likely. **$1,912**

IMAGING CONSIDERATIONS

→**CXR (PA and lateral erect):** CXR usually discovers SPN. It is critical to track down old studies to determine the stability of the nodule over time. Benign nodules usually have dense calcifications, but these may not be readily shown by plain radiographs alone. **$125**

→**CT of the chest with IV contrast:** Modality of choice to evaluate the pulmonary nodule. High-resolution thin sections can show benign calcifications. Malignant nodules are ill defined and have irregular, spiculated margins. If multiple other nodules not visible on the CXR become apparent, then metastasis is a concern. Accurate size measurement is critical and can be performed by 3D computer programs. Nodules 6 mm or less in size may be candidates for image-only follow-up depending on certain, now well accepted criteria: Fleischner Society Guidelines. **$401**

→**Positron emission tomography:** Positron-emitting isotope of glucose is injected IV to determine metabolic activity of the pulmonary nodule. No contraindications, but patients must remain still for scan times of up to an hour. ***Not*** a good test for nodules less than 1 cm in size. Malignant nodules show very high activity. “Cold nodules” are almost assuredly benign. “Warm nodules” can be indeterminate, as lower grade malignancies as well as chronic inflammatory and infectious nodules can accumulate the isotope. **$1,912**

Clinical Entities — Medical Knowledge

Non–Small Cell Cancer

Pφ ***Non–small cell cancers*** are divided into four main types: squamous cell carcinoma (25%), adenocarcinoma (40%), large cell carcinoma (10%), and adenosquamous carcinoma (3%). They are all of bronchial origin with squamous cells traditionally centrally located and adenocarcinoma peripherally located.

TP The typical patient with lung cancer is symptomatic with a cough, hemoptysis, chest pain, or dyspnea. Only 10% to 20% of patients present without symptoms at an early stage of disease due to screening and are ultimately candidates for surgical resection.

Dx Dx is made by minimally invasive biopsy with bronchoscopy or image-guided CT biopsy or directly with a surgical approach and staged with TNM staging.

Tx If nonsurgical biopsy is benign or nondiagnostic in an acceptable surgical candidate, surgical resection is warranted for definitive dx. If nonsurgical biopsy or surgical wedge biopsy shows non–small cell cancer, then appropriate surgical management is lobectomy or pneumonectomy and lymph node dissection as long as the patient has adequate pulmonary reserve. Adjuvant chemotherapy and radiation depend on the final staging based on pathological findings at the time of resection. **See Sabiston 59, Becker 28.**

Small Cell Cancer

Pφ ***Small cell cancer*** is a rapidly growing and aggressive malignancy of bronchial origin that is rarely found as an SPN. It accounts for approximately 15% of lung cancers and has a median survival of 18 months for limited disease (one hemithorax only). It is predominantly found centrally with diffuse mediastinal lymphadenopathy and often has distant metastatic disease at presentation.

TP The typical patient with small cell cancer is usually symptomatic with a cough, hemoptysis, chest pain, dyspnea, or weight loss. Neuromuscular symptoms, neuropathy, or weakness may be present due to a paraneoplastic syndrome.

Dx Dx is made by minimally invasive biopsy with bronchoscopy, image-guided CT biopsy, or directly with a surgical approach.

Tx Surgery has a limited role in small cell cancer unless it is used to make the dx in very early disease. If the dx is made by minimally invasive biopsy or after resection of an SPN, completion staging with CT/MRI of the brain and a bone scan for metastasis should be performed. Tx is platinum-based chemotherapies and external beam radiation therapy. **See Sabiston 59, Becker 28.**

Granuloma

Pφ ***Granulomas*** are predominantly excessive fibrotic reactions to infectious diseases. The etiologies are mostly fungal with *Histoplasma*, *Coccidioides*, and *Blastomyces* being endemic in certain U.S. regions. *Mycobacterium* infections, both tuberculous and nontuberculous, may develop as a granuloma but usually have associated parenchymal disease and central cavitation.

	Certain autoimmune-mediated inflammatory conditions like Wegener's disease and sarcoidosis may present with granulomas, but they are usually multiple.
TP	The typical patient with a granuloma is usually asymptomatic but may give a hx of previous or recurrent upper respiratory infections. Look for positive travel hx or previous habitation in endemic areas.
Dx	Dx is made by review of radiological imaging specifically for the presence of benign calcifications. If such calcifications exist, further observation with follow-up imaging might be most appropriate. If concern exists for underlying malignancy, then biopsy should be performed as stated for non–small cell cancer.
Tx	Surgery has a limited role beyond assisting with dx for granulomas. **See Sabiston 59.**

Congenital Lesion

Pφ	***Congenital lesions*** of the lung are rare, but certain lesions can be asymptomatic or minimally symptomatic and not present until adulthood. Arteriovenous (AV) malformations are common in patients with hereditary hemorrhagic telangectasis. Bronchogenic cysts and intralobar sequestrations can manifest as solitary nodules.
TP	The typical patient with a congenital lesion has been asymptomatic for a long time. AV malformations can grow and lead to shunting and progressive hypoxia. Bronchogenic cysts or intralobar sequestrations often become secondarily infected, causing repeated bouts of pneumonia or rapid growth due to intralesional bleeding.
Dx	Dx can usually be made by review of radiological imaging: specifically, CT for the presence of vascular or cystic structures. Pulmonary angiography and MRI can be helpful.
Tx	Symptomatic AV malformations can often be obliterated via radiologically guided embolization. Surgery has also been advocated for single lesions if the feeding vessel can be identified or even for multiple lesions that can be incorporated into a conservative resection. Surgical resection is routine for symptomatic bronchial cysts and sequestration. **See Sabiston 59.**

Metastasis

Pφ ***Metastasis*** of extrapulmonary malignancies is common via hematogenous spread, specifically for sarcoma, germ cell tumors, breast carcinoma, colorectal carcinoma, renal cell carcinoma, and melanoma. Often these lesions are multiple but may present as a solitary nodule.

TP The typical patient with metastasis related to a prior hx of cancer is usually asymptomatic unless the primary tumor has not been controlled or metastatic lesions are widespread in the lungs.

Dx Dx is made by minimally invasive biopsy with bronchoscopy or image-guided CT biopsy or directly with a surgical approach.

Tx Surgical pulmonary metastasectomy has shown survival benefit for sarcomas, germ cell tumors, and most epithelial carcinomas when the primary tumor has been controlled. Often surgical biopsy may be required to r/o a primary lung cancer. Prognostic factors for metastatic resection include histologic subtype, single site of metastasis, prolonged disease-free interval before metastasis (>36 months), and complete resectability for multiple nodules. **See Sabiston 59, Becker 28.**

ZEBRA ZONE

Extrapulmonary densities: Soft tissue masses, osteophytes, nipple shadows, and EKG leads can all falsely be interpreted as an SPN. Skin markers and repeat imaging can further evaluate these lesions correctly as not in the lung proper.

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
Early lung cancer action project; overall design and findings from baseline screening

Authors
Henschke CI, McCauley DI, Yankelevitz DF, et al.

Reference
Lancet 1999;354(9173):99–105

Problem
Are screening protocols for lung cancer, which did not seem to benefit the average risk population, effective at decreasing mortality in a high-risk subset of patients?

Intervention
High-risk patients (10 pack/year smoking hx and age > 60 years) were screened with annual low-dose CT and CXR as a screening tool.

Quality of evidence
Prospective nonrandomized trial in 1,000 high-risk patients

Outcome/effect
Low-dose CT was better than CXR in detecting noncalcified nodules (three times more likely), malignant tumors (four times more likely), and stage I tumors (six times more likely). With improved early detection of lung cancer follow-up, preliminary data from this project have identified 8-year cure rates of 95% for stage I screen-diagnosed non–small cell lung cancer (NSCLC).

Historical significance/comments
This article supports the use of low-dose CT for screening in a defined protocol for high-risk patients for NSCLC. As ongoing follow-up accrues, these data will be further scrutinized. This study is an excellent example of how to identify the appropriate target population for the most cost-effective use of technology.

Interpersonal and Communication Skills

Dealing with Personal Guilt
A 58-year-old male smoker with a newly diagnosed SPN realizes his habit may have led to this process and expresses personal guilt. It is not appropriate to chastise or convey disapproval of the patient's past smoking; that cannot be changed. I try to focus on the benefits of smoking cessation even at this point, not only for preventing other cancers but also to limit cardiac and vascular disease, as well as to promote a healthier environment for those around him. As a surgeon I also highlight the fact that his lesion is most likely at an early stage and amenable to resection, unlike 80% of patients who present with lung cancer and are not candidates for surgery.

Professionalism

Principle of Primacy of Patient Welfare; Commitment to Professional Responsibilities
If your sister is found to have an SPN on routine CXR, how would you interact with her doctor? In other words, would you insist she be seen immediately by a specialist at a high-volume center?

As a basic principle, it is important to respect the boundary between family and professional practice. Objectivity does not exist when the patient is a close relative or friend. It is important to honor the relationship that your sister (or any close relative) may have with her physician and to offer your opinion only when asked. If you have serious concerns about the management, it is appropriate to ask your sister if she would like you to discuss the issues with her physician.

Systems-Based Practice

Collaboration within Postoperative Nursing

Patients frequently leave the OR with ancillary tubes, drains, catheters, IV lines, arterial lines, and/or temporary epicardial pacemaker wires. Each of these devices serves a purpose. The surgical team must convey to the postoperative nursing team its specific knowledge about each device: its location, how it is secured, how it is connected to other devices, its purpose, and how it should be managed. Relevant information should also be documented in the patient's record and on the device. When connecting to an indwelling device, one must trace the path to where the device enters the patient and use the written information as a double check. Adverse outcomes can occur when (1) the functions of devices are assumed from their appearance (such as when Foley catheters are used as gastrostomy tubes); (2) devices are no longer secured; (3) connections come apart; (4) devices are reconnected; (5) devices are contaminated; (6) providers assume that devices are out, rather than in; (7) devices are cut off rather than removed; and (8) force is used to overcome unexpected resistance while removing them. Good written and verbal communication between the OR staff and the postoperative nursing staff will minimize errors and adverse outcomes.

Have you had the opportunity to evaluate a patient with chest pain or a pulmonary mass? How well did services collaborate to evaluate the problem efficiently? How good were the interpersonal skills of your team as your patient was "in limbo" between diagnostic tests. Consider reviewing your patient's course in the context of the Competency Self-Assessment Form on page 35, which can also be found as a Word document on the book's Web site at www.studentconsult.com

Professor’s Pearls: Cardiothoracic Surgery

Review Section

Consider the following clinical problems and questions posed. Then refer to the professor’s discussion of these issues.

1) A 36-year-old male presents with chest pain, weight loss, and a nonspecific cough. A PA/lateral CXR shows an anterior mediastinal mass. What is the workup of this patient?

2) A 68-year-old female nonsmoker with a hx of recurrent melanoma treated 4 years ago presents with an abnormal CXR showing a noncalcified pulmonary nodule in the right lower lobe. This nodule was not present at time of dx of melanoma. She is asymptomatic with a normal physical examination and without lymphadenopathy. What is the next step in tx?

3) A 73-year-old male with a hx of coronary artery disease and hypertension presents with an acute onset of chest pain. Coronary angiography shows a 95% lesion of the proximal right coronary artery. What is the next step in management?

4) A 52-year-old diabetic female presents with chest pain on exertion. A stress test shows ischemia, and coronary angiography shows a 90% lesion of the mid-left anterior descending artery, an 85% lesion of the mid-diagonal artery, and a 95% lesion of the distal right coronary artery. What is the next step in management?

Discussion by Scott M. Goldman, MD, Chief of Surgery, Main Line Health System, Wynnewood, Pennsylvania

Answer 1
A patient with an anterior mediastinal mass requires a physical examination to evaluate any areas of lymphadenopathy, and any neurological symptoms. CT can characterize the lesion to determine in what compartment this mass exists and if it originates from the thyroid or thymus gland, or if it is lymphadenopathy. Laboratory tests such as α-fetoprotein and β-hCG would suggest a malignant nonseminomatous germ cell tumor. Ultimately, however, tissue dx is necessary and can be accomplished via a Chamberlain procedure, VATS, or a sternotomy.

Answer 2
This patient requires CT of the chest to evaluate the possible existence of multiple nodules as well as PET to look for other foci of possible metastatic disease since she has a prior hx of melanoma. Pulmonary function tests need to be performed to determine the

patient's ability to undergo a lung resection. Although metastatic disease is the most likely dx, surgical excision may be required for diagnostic purposes. Surgical pulmonary metastasectomy has shown improved survival for sarcomas, germ cell tumors, and a few epithelial carcinomas provided that the primary tumor has been controlled.

Answer 3
This patient has a potentially stentable lesion as it is single, proximal, and not involving the left anterior descending artery. In the acute setting, coronary angiography can be both diagnostic and therapeutic with thrombolytics and/or angioplasty and stent placement.

Answer 4
This patient has more than two lesions that are not proximally located, diabetes, and involvement of the left anterior descending artery. CABG would lead to a better long-term outcome in this patient as well as being the more cost effective treatment. This is a situation in which CABG is preferable over coronary stenting.

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Chapter 62
Persistent Jaundice in a 1-Month-Old Infant (Case 43)

David A. Rogers MD, MHPE

Differential Diagnosis

Biliary atresia	Biliary hypoplasia
Choledochal cysts	Inspissated bile syndrome

Speaking Intelligently

I am usually asked to see a jaundiced infant because there is a suspicion that the patient has a congenital anatomic defect of the biliary system that may be causing the jaundice. My goal is to make certain that the proper diagnostic tests are done and then prepare the patient and the family for the surgical procedure.

PATIENT CARE

Clinical Thinking

- Surgical causes of jaundice usually cause an elevation in conjugated bilirubin and so can be detected with a direct bilirubin serum level.
- For optimal outcome in biliary atresia, the Kasai procedure should be performed by 6 weeks of age, and so there is need for a timely workup and accurate dx.

History

- Determine when jaundice was first noted and its course.
- Review all labs done prior to surgical consultation. Conjugated hyperbilirubinemia from surgical causes tends to continuously progress until it is treated. There are a number of other nonsurgical causes that must be excluded (e.g., maternal-infant ABO incompatibility).
- A family hx of α_1-antitrypson deficiency or cystic fibrosis will make these diagnoses more likely. Maternal pregnancy hx can provide clues about congenital infection causing jaundice.
- Stool color is quite important as obstruction of the biliary system will result in “acholic” stools, which lack bile pigment and are white or clay colored.

Physical Examination

- The main focus is the size and texture of the liver. Patients with biliary atresia develop hepatomegaly, and the liver is firm to palpation.
- The general physical examination may reveal diagnostic clues of an intrauterine infection.

Tests for Consideration

- **Hemoglobin level:** Low levels may be indicative of a hematological disorder. **$25**
- **Fractionated bilirubin:** Will show whether the jaundice is due to conjugated or unconjugated bilirubin. Most causes that require surgical correction are related to conjugated bilirubin. **$25**
- **Comprehensive metabolic profile:** Will include most liver function tests. **$45**
- **α_1-Antitrypson levels:** To exclude this specific deficiency. **$70**
- **Torch titers:** Allows for evaluation of intrauterine infections with toxoplasmosis, other infections (e.g., syphilis), rubella, herpes. Urine for cytomegalovirus should be sent by 3 weeks of age. **$275**
- **Newborn screen:** Checks for hypothyroidism, cystic fibrosis, and galactosemia that can cause direct hyperbilirubinemia. **$250**

IMAGING CONSIDERATIONS

➔**Ultrasonography:** First imaging tool in pediatrics. Fast, no radiation, and no need for sedation. Choledochal cyst easily seen, as is the remainder of the gallbladder/biliary tree. **$150**

➔**Biliary scintography:** Requires radioactive isotope to be taken up by the liver and excreted into biliary ducts. No excretion: biliary atresia. Accumulation in cyst: choledochal cyst. **$450**

➔**Magnetic resonance cholangiopancreatography (MRCP):** MRI technique creates 3D images of the biliary tree. Limited value in the neonate due to small anatomy and need for sedation. **$900**

Clinical Entities — Medical Knowledge

Biliary Atresia

Pφ Biliary atresia is an obliteration of the biliary system. Its precise cause is unknown. Pathologic changes in the liver include portal tract edema, bile duct proliferation, and portal and periductular inflammation and hepatocyte injury.

TP Jaundice beyond 2 weeks is usually the first sign. The patient will have white or "acholic" stools, dark urine, and hepatomegaly. With time the liver becomes firm to palpation.

Dx Serum bilirubin will be elevated, with the direct fraction greater than 50% of the total. Transaminases and alkaline phosphatase are also elevated. Hepatobiliary scintography will show uptake into the liver without excretion. A liver biopsy provides definitive dx. It can be done percutaneously, or as a part of an exploration with cholangiography.

Tx The extrahepatic bile duct is excised and segment of jejunum is sewn into the fibrotic porta hepatis in a portoenterostomy or Kasai procedure. The bile then drains from the liver via the small hepatic biliary ductules. Liver transplantation is required for those who do not develop bile flow or who ultimately develop fibrosis of the intrahepatic bile ducts. **See Sabiston 71, Becker 57.**

Choledochal Cysts

Pφ Two main etiologies have been proposed. The first is a malformation of the pancreaticobiliary duct resulting in reflux of the pancreatic juices into the biliary system. The other possible cause is an obstruction of the distal common bile duct.

TP These cysts are sometimes detected on prenatal screening. In the neonate they typically present as a conjugated hyperbilirubinemia. In older children, they may present as recurrent abdominal pain with or without intermittent jaundice.

Dx In the neonatal period, the dx is most often made by ultrasonography. MRCP has been used in neonates but is more helpful in older children where the ductal structures are larger. Endoscopic retrograde cholangiopancreatography has also been used in older children.

Tx Tx is complete excision. The most common type of cyst involves the extrahepatic biliary system; in these patients the bile duct at the porta hepatis is connected to a Roux-en-y loop of jejunum to allow bile drainage. **See Sabiston 52, 71; Becker 57.**

Biliary Hypoplasia

Pφ This entity has a reduced number of intrahepatic bile ducts. It may occur in isolation or as part of arteriohepatic dysplasia (or Alagille's syndrome.) The etiology is unclear.

TP Patients with Alagille's syndrome have dysmorphic triangular facies with a broad forehead, deep set widely spaced eyes, and a small mandible.

Dx If there are no manifestations of Alagille's syndrome, then the diagnostic evaluation is similar to that for biliary atresia. The liver biopsy will show a reduced number of intrahepatic bile ducts.

Tx Patients with mild forms can be managed medically. Patients with the severe involvement have been treated with a portoenterostomy. **See Sabiston 71, Becker 57.**

Inspissated Bile Syndrome

Pφ Mechanical obstruction of the biliary system can occur from thick bile sludge that is associated with a number of conditions, including massive hemolysis due to blood group incompatibility, cystic fibrosis, and cholestasis associated with parenteral nutrition.

TP Patients with severe manifestations will have a clinical and radiological presentation similar to biliary atresia. Patients with milder forms will be excreting bile and have mild jaundice.

Dx The presence of the underlying disorder is the main clue to this dx. In some cases the dx is confirmed on cholangiography.

Tx This syndrome can improve with time. More severely affected patients are treated with agents that improve bile flow (e.g., phenobarbital). Irrigating the biliary system with saline may be done if cholangiography has been performed, but is rarely required.

ZEBRA ZONE

a. α_1-Antitrypsin deficiency: Approximately 10% of patients with this disease will present with cholestasis. It causes chronic liver disease and emphysema in older children and adults.

b. Cystic fibrosis: This disease may present as cholestasis or meconium ileus syndrome in infants. **See Sabiston 59, 71; Becker 57.**

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
Technique and results of operative management of biliary atresia

Authors
Kasai M, Suzuki S, Ohashi E, Ohi R, Chiba C, Okamoto A

Reference
World Journal of Surgery 1978;2:571–579

Problem
Poor outcomes for surgery for biliary atresia

Intervention
New surgical technique that extends the excision of the biliary system into the fibrous tissue at the porta hepatis

Comparison/control (quality of evidence)
Single institutional prospective review of a novel technique

Outcome/effect
Prior to the adoption of this procedure, the cure rate for surgical excision of the biliary tree (hepatic portoenterostomy) was 30%. With the extension of the excision, the cure rate improved to 55%, which represented a significant improvement.

Historical significance/comments
This technique was reported in the Japanese literature in 1959. It became well known after this report in English almost 20 years later and became known as the Kasai procedure.

Interpersonal and Communication Skills

Talking to Parents: Hope When Things Seem Bleak
Conversations with families of patients with suspected biliary atresia are complex because the disease is poorly understood and there are no simple answers to the question, "Why did this happen to my baby?" The current understanding of the cause of this disease can be summarized with the family, but the surgeon is left explaining that the precise pathogenesis of the disease is not known. To complicate matters, the surgeon must acknowledge in the preoperative counseling that even a properly done Kasai procedure may not result in any bile flow or reversal of the jaundice. Finally, the disease is progressive and many patients will ultimately require a liver transplant even when the Kasai procedure is successful. While this information is often perceived as discouraging, it is important for the surgeon to be completely honest about the child's condition and the role of surgery. Hope can be offered in this situation as some patients respond well to the Kasai procedure, and therapies are evolving and improving for those who do not respond.

Professionalism

Commitment to Professional Competence

The surgeon is generally consulted about a jaundiced neonate by a neonatologist or primary care provider who has done some or all of the evaluation for this problem. Additionally, a pediatric gastroenterologist may have been consulted about the patient. While it is important to be certain that the child has been completely evaluated, it is also important to recognize that different physicians may have different opinions about the cause of the jaundice even after the evaluation is completed. Differing opinions must be discussed among physicians in a respectful way. While differences of medical opinions should be discussed openly with the family, one should be sensitive to the fact that these differences may cause the family to have even greater anxiety about their child's condition. Thus, after a discussion of the various options, it is preferable for the physicians to have a consensus recommendation to present to the family.

Systems-Based Practice

Reimbursement: Medicaid

The dx of biliary atresia in a child can have substantial financial consequences for the patient's family. Insured patients will likely have coverage for the cost of portoenterostomy and subsequent liver transplantation when needed. Medicaid will cover a portion of the costs of treatment for those families without health insurance, and for those who fall below certain income levels.

Medicaid is the federal insurance program designed to cover health care for individuals and families with low incomes and resources. Established in 1965, the program is run and funded as a joint federal-state program, with states electing to participate (all do). In 2006 the combined federal and state funding for Medicaid was $313 billion, meaning that approximately 15% of the nation's entire health-care costs were covered by Medicaid. The federal government provides certain guidelines that states must follow, but the individual states establish their own programs, each with a state-specific name (such as Medi-Cal in California) and its own set of eligibility requirements and coverage. The federal government then funds half or more of the total cost of the program, depending on the poverty level of the state. Medicaid is contrasted with the federal insurance program designed to care for the elderly and disabled, known as Medicare.

There are many similarities between Medicaid and Medicare, but a few key differences are worth noting. First, as mentioned, is that

Medicaid is administered at the state level. Second, Medicaid in general covers a broader range of health-care needs than Medicare. Third, Medicaid in general provides long-term care benefits, while Medicare does not; therefore, a significant number of the elderly living in nursing homes eventually go on Medicaid, since Medicare does not cover long-term care.

Chapter 63
Newborn Baby with a Large Abdominal Wall Defect (Case 44)

Dan Poenaru MD, MHPE

Differential Diagnosis

Gastroschisis	Omphalocele
Umbilical hernia	Epigastric hernia

Speaking Intelligently

Abdominal wall defects are often diagnosed antenatally with prenatal ultrasonography. After assessing the patient's airway, breathing, and circulation to be certain that the baby is stable, I inspect the defect to make certain that it is covered to prevent fluid and heat losses. My next step is to look for associated anomalies both clinically and through selected investigations. I decide on my surgical approach, and after a discussion with the family, proceed with the surgery, generally within a few hours of the birth.

PATIENT CARE

Clinical Thinking

- The first decision to make is whether one is dealing with gastroschisis, where the defect is to the right side of the umbilicus and the viscera are totally exposed, or omphalocele, which protrudes through the umbilicus and is usually covered by a membrane (unless the membrane is broken). The former is easier to close and has few associated anomalies, while the latter is more difficult to close and may have other major associated anomalies.

- A hernia of the cord is a very small omphalocele. It is generally easy to repair unless it was not recognized and the umbilical clamp placed across the bowel in the omphalocele sac.
- Umbilical hernias and epigastric hernias are not surgical emergencies (like congenital abdominal wall defects) and are not addressed during the neonatal period. An umbilical hernia involves a defect within the umbilical ring and most will resolve spontaneously. An epigastric hernia occurs in the upper abdomen and will not close spontaneously.

History

- As the major abdominal wall defects are obvious at birth, hx may be limited to the pregnancy hx and prenatal ultrasonography.
- In the case of umbilical and epigastric hernias, identifying abdominal pain localized to the defect area is important.

Physical Examination

- Identify whether the major defect is at the umbilicus (omphalocele) or to the right of it (gastroschisis).
- In the patients with gastroschisis, ensure that the bowel is not twisted or falling to one side; look for possible intestinal atresias.
- In the patients with omphalocele, look for signs of associated abnormalities (heart murmur, sternal/bladder defects). Also be certain to examine the patient thoroughly for signs of syndromes associated with omphalocele (e.g., macroglossia associated with Beckwith-Wiedemann syndrome).
- In minor abdominal wall defects, inspect the midline fascia for defects, and assess the size of the umbilical ring (*not* of the protrusion).

Tests for Consideration

- **Basic metabolic profile:** Particularly note glucose level with omphalocele. **$68**
- **Karyotype with high-resolution chromosomes:** To identify chromosomal anomalies in infants with gastroschisis and omphalocele. **$150**

IMAGING CONSIDERATIONS

➔**Chest radiography (AP/lateral views):** Simple tool to evaluate lungs, heart, and mediastinum. Minimal radiation exposure. **$150**

➔**Echocardiography:** Fast, readily available means to evaluate congenital heart disease. **$250**

➔**Renal ultrasonography:** Screening tool to evaluate genitourinary anatomy. **$225**

Clinical Entities **Medical Knowledge**

Omphalocele

Pφ Caused by a faulty closure of lateral abdominal folds, leaving a defect through which hollow viscera and liver may prolapse. All patients have intestinal malrotation from inability of prolapsed gut to undergo the developmental intestinal rotation.

TP Presents as a large sac protruding through the umbilical ring, containing viscera and often liver. The abdominal wall defect may be quite large (>5 cm), and the abdominal cavity small. The sac may rupture prenatally, making it indistinguishable from gastroschisis.

Dx Clinical dx is usually obvious. Investigations required to r/o associated anomalies present in more than 50%. They include midline anomalies of the heart, sternum, and diaphragm. Chromosomes should also be checked.

Tx Immediate defect closure; in 50% of cases requires "silo" mesh placement for gradual reduction of contents into abdominal cavity. Giant omphaloceles contain predominantly liver, which makes primary repair difficult. Occasionally large defects are closed with skin only or allowed to epithelialize, leaving the ventral hernia for later repair. **See Sabiston 71, Becker 57.**

Gastroschisis

Pφ Thought to be caused by vascular disruption of the right omphalomesenteric artery. Occasional associated intestinal atresias are likely mechanical or vascular in origin. All patients have intestinal malrotation from inability of prolapsed gut to undergo developmental intestinal rotation.

TP Prolapsed contents are mostly gut with occasional gonads or solid viscera. Defect in abdominal wall is usually small. The bowel is frequently covered by a "fibrous peel" from prenatal exposure to amniotic fluid.

Dx Dx is obvious in most circumstances. Contrast study of GI tract postoperatively may be required for intestinal atresias.

Tx Occasionally early cesarean section is required because of ultrasonic evidence of intestinal ischemia. Once the patient is born, the defect may be repaired immediately after stabilization, and this is feasible in 90% of cases. When the bowel cannot be reduced safely, it is placed in a silo created by joining silicone mesh to the edge of the abdominal wall defect. In these cases, the bowel is gradually reduced over a period of days. A prolonged ileus is the rule postoperatively because of GI dysmotility, and the infants must be maintained on TPN until the ileus resolves. Associated intestinal atresias can be repaired at time of original procedure or 3 to 4 weeks later. **See Sabiston 71, Becker 57.**

Umbilical Hernia	
Pφ	Persistence of umbilical ring in the postneonatal period allows for herniation of preperitoneal fat and/or intestine.
TP	Most defects are asymptomatic, though small defects may occasionally cause pain through prolapse of preperitoneal fat. Bowel obstruction due to incarceration is quite rare. The defect size in the abdominal wall usually is less than 2 cm.
Dx	Dx is obvious in most cases. Occasionally epigastric hernias may present very close to the umbilical ring.
Tx	Most umbilical hernias resolve spontaneously by 4 to 6 years of age. Elective repair is recommended only if they persist beyond that age, or are symptomatic. Hernias with defects over 2 cm are less likely to close spontaneously and may require earlier repair. **See Sabiston 71, Becker 16.**

Epigastric Hernia	
Pφ	A small disruption in the fibers of the midline fascia may lead to herniation of preperitoneal fat.
TP	Presents either as an asymptomatic midline “lump” or a small midline defect with occasional pain episodes. The actual defect may be so small as to be nonpalpable, especially in obese children.
Dx	Dx is clinical. Occasionally ultrasonography may be required to confirm the presence of a small epigastric hernia in a child with localized epigastric pain with no other likely cause.
Tx	Surgical repair is recommended in all epigastric hernias, as spontaneous resolution is not possible. Hernias close to the umbilicus can be repaired through a supraumbilical incision. **See Sabiston 71.**

ZEBRA ZONE

a. **Pentalogy of Cantrell** consists of ectopia cordis or cardiac defects, omphalocele, sternal defects, diaphragmatic, and pericardial defects.

b. **Diastasis recti** is an innocuous condition in which the rectus abdominis muscles do not meet in the midline, and the linea alba, which is thin in children, may protrude for several centimeters above the umbilicus. Despite its anxiety-producing appearance, this condition requires no tx as it resolves spontaneously with age as the midline alba gets stronger. **See Sabiston 43.**

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
Improved outcomes in the treatment of gastroschisis using preformed silo and delayed repair approach

Authors
Schlatter M, Norris K, Uitvlugt N, DeCou J, Connors R

Reference
Journal of Pediatric Surgery 2003;38:459–464

Problem
Gastroschisis was traditionally treated with immediate primary surgical repair but there were many complications. The authors looked to reduce the complications and costs of gastroschisis tx to improve outcome.

Intervention
Delayed closure with silo placement

Quality of evidence
Retrospective case-control study of 65 infants

Outcome/effect
A historical control group of patients who had undergone immediate repair were compared to patients who were treated with a silo initially followed by delayed fascial closure. Delayed closure with silo placement led to improved outcomes, including improved fascial closure rates, fewer ventilator days, more rapid return of bowel function, shorter length of stay, and fewer complications.

Historical significance/comments
One of the earlier studies documenting good results with a “gentle” initial management of gastroschisis. Such studies have contributed to the increased use of neonatal, silo-based, “nonsurgical” tx of gastroschisis.

Interpersonal and Communication Skills

Talking to Parents: Dealing with Anxiety When There Is a “Gross” Physical Abnormality
The birth of a child with a major abdominal defect can generate tremendous anxiety for the parents. One way to minimize fear is through prenatal consultation with parents once the ultrasound dx is made. At that time, a detailed explanation of the condition and of the steps and options in its management can be presented, and the parents can be informed about the various postnatal scenarios. When the child is born, the parents will be better prepared for the (potentially frightening) appearance of their baby’s abdominal wall abnormality and for the planned surgical repair.

Professionalism

Commitment to Professional Responsibilities
The surgery examination shows a picture: Is it (A) an omphalocele or (B) gastroschisis? You’re not sure. The student sitting next to you has circled (B).

The medical profession is based on trust and is a profession on which human lives depend. There should be zero tolerance of cheating at any stage of medical education. Should we not assume that dishonesty in medical school will predict future dishonesty with patients, colleagues, insurers, and government?[1]

Medical schools should be the major force to imbue future doctors with integrity and ethical sensitivity. There are troubling data points, if inconclusive, that suggest that during medical school the ethical behavior of medical students does not necessarily improve; indeed, moral and ethical development may actually stop or even regress.[2] Among the factors contributing to this distressing phenomenon are the overemphasis on grades and competition, negative role models, student abuse, a hidden curriculum that delivers negative messages, a culture of student unwillingness to police themselves, and an institutional tolerance of cheating.[1]

An institutional culture of integrity is essential. It begins with the academic and clinical leaders of the institution setting personal examples of integrity and requires a partnership with the students in which they play an active part in its creation and nurturing. The emphasis should be less on "reporting" breaches and more on creating an environment of peer pressure in which unprofessional behavior simply is not acceptable.[3]

Systems-Based Practice

Reimbursement: Consumer-Driven Health Care

Passing some of the risk for the financial cost of health care to the decision makers—physicians and hospitals—has been a method for reducing overall health-care costs. Beginning in the late 1990s, employers and insurers increasingly started moving some of this risk to the patients themselves—a change referred to as consumer-driven health care (CDH). In CDH, the consumer (or patient) plays a more central role in determining how he or she spends health-care dollars. In a traditional managed care plan, costs covered are determined solely by the company. In a CDH plan, money can be placed in a tax-deferred health savings account and the patient determines how to spend it. To limit the amount of risk that a patient takes on, most CDH plans offer a high-deductible health plan (HDHP), also known as catastrophic coverage, that is initiated at a predetermined amount. Because very few people will require such expensive care, a HDHP can offer such coverage for a relatively small premium.

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Chapter 64
Newborn Infant with Labored Breathing and Hypoxemia (Case 45)

Andreas H. Meier MD

Differential Diagnosis

Congenital diaphragmatic hernia (CDH)	Congenital cystic adenomatoid malformation (CCAM)	Sequestration
Congenital lobar emphysema (CLE)	Tracheomalacia	

Speaking Intelligently

Respiratory distress in the neonate can be caused by many problems. As a surgeon, I tend to group them into those causes that have an anatomic basis that will require surgical correction and those conditions that are medical in nature. Therefore, my first step is to differentiate between a medical and surgical etiology of the respiratory distress. My main involvement with the patients who have a medical cause of respiratory distress is to provide cannulation so that they can be placed on extracorporeal membrane oxygenation as part of the medical therapy. I am involved in the diagnostic testing for those conditions that require surgical correction and am also responsible for preparing these patients for surgery.

PATIENT CARE

Clinical Thinking

- Surgical causes for respiratory distress usually involve the airway, lungs, or diaphragm. Treatment options differ dramatically depending on the underlying cause.

History

- Many conditions are apparent on prenatal ultrasonography (e.g., congenital diaphragmatic hernia).
- The family hx should include questions about siblings or relatives with similar problems.

- Ask the infant's nurse or neonatologist how the problem started. Choking with feeds, regurgitation, and the course and severity of the respiratory distress may provide clues to the etiology.

Physical Examination

- Assess the infant's airway and breathing. This will include evaluating for abnormal airway signs, oxygen saturation, and ventilatory support requirements.
- Evaluation of the chest includes determining whether or not breath sounds are present bilaterally. The chest should be inspected during respirations to be certain that both sides move equally.
- The abdominal contour may provide clues about etiology of the respiratory problems.
- Complete a general examination to include listening for a heart murmur and evaluating the anal opening and extremities.

Tests for Consideration

- **Blood gas:** To further evaluate the infant's respiratory status. **$100**
- **CBC:** Abnormal values may suggest underlying sepsis. **$40**

IMAGING CONSIDERATIONS

→**CXR (AP/lateral views):** Simple tool to evaluate lungs, heart, and mediastinum. Minimal radiation exposure. **$150**

→**Chest CT:** Usually unnecessary. Larger radiation exposure. **$800**

→**Videofluoroscopy:** Dynamic study used to look for airway collapse during inspiration with suspected tracheomalacia. Moderate radiation exposure. **$550**

Clinical Entities — Medical Knowledge

Congenital Diaphragmatic Hernia

Pφ CDH represents a defect in the diaphragm with bowel, stomach, spleen, or liver herniating into the chest cavity. The left side is more commonly involved. The underlying etiology appears to be likely related to abnormal lung development. Both lungs are hypoplastic with abnormally reactive vasculature.

TP Patients can present without any symptoms or be in severe shock caused by pulmonary hypertension.

Dx CDH is often detected on prenatal ultrasonography, and the extent of involvement is often a predictor of the clinical course after birth. Postnatally the combination of a scaphoid abdomen and chest radiograph findings secures the dx.

Tx It is most important to minimize exacerbation of the pulmonary hypertension. Most babies require intubation to avoid hypoxemia. The infants should be handled as little as possible. An orogastric tube is passed for gastric decompression. Metabolic acidosis is aggressively corrected. Extracorporeal membrane oxygenation (ECMO) is used for patients with reasonable initial ventilation and oxygenation that fail conventional treatment strategies. Surgical repair should be postponed until the pulmonary hypertension stabilizes. Depending on the size of the defect, primary repair or patch plasty of the diaphragm is performed. **See Sabiston 71, Becker 56.**

Congenital Cystic Adenomatoid Malformation

Pφ CCAMs appear to be caused by developmental arrest of fetal lung maturation and bronchial segmentation resulting in areas of dysplastic lung and bronchial tissue. The resulting cysts range in size from microscopic to very large.

TP Symptoms vary widely. Some children remain asymptomatic for years and are incidentally diagnosed on a chest radiograph done for another reason. The most severe forms cause mediastinal shift in utero and result in fetal hydrops if not treated early. Postnatal symptoms include respiratory distress, which usually occurs in the newborn period. Later presentation typically involves pneumonia that fails to respond to antibiotics or recurs.

Dx CCAMs can often be diagnosed on prenatal ultrasonography. It is known that some involute without intervention. Chest radiograph and CT establish dx after birth.

Tx CCAMs that are present after birth usually require surgical removal, as they are predisposed to infection and, to a smaller degree, malignant degeneration. Timing of the operation depends on the infant's symptoms. Respiratory distress usually requires early intervention, whereas asymptomatic lesions typically are removed at 6 months to 1 year of age to avoid infectious complications. **See Sabiston 71.**

Sequestration

Pφ This is a segment of lung tissue that has a systemic blood supply, usually from the aorta below the diaphragm. It is thought to develop from an accessory ventral lung bud. The abnormal lung segment may be located within the normal lung or may be completely separate.

TP Depending on size, patients with sequestration may rarely present early with respiratory distress. More commonly, the presentation is later with chronic or recurrent pneumonia. Some are picked up on routine chest radiography done for another reason.

Dx Chest radiography may show a dense opacity in the posterior aspect of the lower lobe, more commonly on the left side. Systemic blood supply may be demonstrated on CT or MRI. Angiography is no longer recommended.

Tx These lesions should be surgically excised due to risk for infection. Whereas extrapulmonary lesions can be resected without loss of normal lung, intrapulmonary sequestrations may require a lobectomy. **See Sabiston 71, Becker 56.**

Congenital Lobar Emphysema (CLE)

Pφ In CLE, there is overinflation of a lung lobe, resulting compression of the adjacent lung, and possible mediastinal shift. This can be due to intrinsic or extrinsic bronchial obstruction, alveolar fibrosis or hyperplasia, or diminished bronchial branching. CLE occurs more commonly in males, and the left upper and right middle lobes are most often affected.

TP Most symptomatic patients present early with significant respiratory distress.

Dx Percussion of the affected side may show hyperresonance. Breath sounds are typically diminished. The trachea may also be shifted to the opposite side. Chest radiography establishes the dx. The classic radiographic finding is a hyperlucent lung with depression of the diaphragm and mediastinal shift.

Tx Asymptomatic patients do not require treatment. If symptoms are present, the CLE needs to be resected, often emergently. Anesthesia management in the operating room can be challenging as positive pressure ventilation may lead to an acute exacerbation of the symptoms. **See Sabiston 71, Becker 56.**

Tracheomalacia

Pφ Malformed or abnormally soft tracheal cartilages cause the trachea to partially collapse during inspiration. Esophageal atresia is a common cause as the dilated proximal esophagus compresses the trachea, resulting in soft cartilaginous rings that collapse on inspiration.

TP The classic presentation is respiratory distress with inspiratory strider and retractions in a newborn infant. This condition often causes a “seal bark” cough in patients with esophageal atresia.

Dx Collapse of the airway can be seen on dynamic fluoroscopy. Bronchoscopy with the patient spontaneously breathing can also identify the problem.

Tx This is commonly a self-limited problem and does not require surgical intervention. Most infants outgrow their symptoms with increasing tracheal diameter. Cases of severe respiratory distress may include dying spells, failure to extubate, and repeated pneumonias; in these cases the trachea can be stented open by performing an aortopexy. This procedure pulls the aortic arch closer to the anterior chest wall, and as the anterior trachea moves with the arch, the diameter of the airway improves.
See Sabiston 57, Becker 56.

ZEBRA ZONE

Editor's note: In most cases of neonatal respiratory distress the underlying etiology is medical. Therefore, one could consider the surgical causes for respiratory distress the true "zebras" of this dx.

Practice-Based Learning and Improvement: Morbidity and Mortality Self-Assessment Form

Complication	Cardiac arrest
Type	Error in judgment; possibly preventable
Surgery performed	Pulmonary lobectomy (after the arrest)
Patient's disease	Congenital lobar emphysema
Presentation	The patient was slightly tachypneic but otherwise stable in the OR and suddenly had a cardiac arrest as he was being intubated.
Intervention	Emergent thoracotomy as soon as the surgeon arrived
Outcome	Survived
Risk factors	Presence of the disease
How were risks addressed?	There is no preventive measure except alertness to the possibility.

What happened?	The bronchus is abnormal in patients with congenital lobar emphysema. When positive pressure is applied to the airway, the pulmonary lobe may begin to expand rapidly, causing a shift in the mediastinum that abruptly decreases venous return to the heart and leads to cardiac arrest.
What could have been done differently?	The surgeon and surgical team should have already been scrubbed and ready to operate immediately. The surgeon and anesthesiologists should have discussed the possibility of this complication prior to induction of anesthesia.
Would outcome have been different?	No

Interpersonal and Communication Skills

Talking to Parents: Setting Up Channels for Good Communication

Newborn respiratory distress is a frightening experience for the family. It is important to detail the underlying problem, evaluation process, and available treatment options. Parents need adequate time to express their fears and ask questions. Discussing the baby's care in understandable terms and listening carefully to caregivers' observations and input will establish parents' trust of the pediatric surgeon and the health-care team.

As most of these patients are comanaged by pediatric surgeons and neonatologists, it is crucial that treating clinicians from both services discuss the patient's status and care plan at least once daily, with the frequency of discussions determined by changes in the infant's status. It is of utmost importance to provide a consistent message when members of any team talk to the family, and it is essential that channels of communication remain open on all levels. Choosing a primary contact from the team to funnel most information to the family will help avoid parental confusion and their becoming overwhelmed by uncoordinated specialist reports, and will help build rapport and consistency upon which the parents can rely.

Professionalism

Commitment to Maintaining Appropriate Relations with Patients

It is a stressful situation for parents to have an ill newborn child with breathing problems cared for in a frightening, equipment-laden environment like the neonatal ICU. We as health-care providers often are so accustomed to dealing with sick patients that we may appear disengaged when talking to the families. *Consider how you would feel about the situation if this were your child*. Stay compassionate throughout all interactions with the parents. Be honest when talking about the baby's status, but deliver especially bad news to the family in a way that you feel will enable them to best handle the information. Remember that privacy can be an issue in the neotatal ICU. Longer and more difficult discussions should be held in a more comfortable and confidential setting.

Systems-Based Practice

Operations: Assessing Local Resources and Deciding When to Transfer

Neonatal respiratory distress has a wide variety of underlying etiologies and involves diverse and sometimes complex treatment options. Availability of these treatment options depends on the resources of the health-care system. If resources are limited or advanced technologies (e.g., ECMO) are not available, it is important to identify the threshold when care should be transferred to another center. Trying to accomplish too much in an environment with limited resources can be detrimental. Establishing a relationship with appropriate referral centers provides access to further expertise, thereby optimizing care and assuring that an infant can be safely transported.

Chapter 65
Vomiting in an Infant (Case 46)

Celeste M. Hollands MD

Differential Diagnosis

Esophageal atresia	Midgut volvulus	Pyloric stenosis
Bowel atresias	Gastroesophageal reflux disease	

Speaking Intelligently

I am usually called to evaluate an infant with vomiting because there is a concern that the child requires an operation. My primary goal is to determine whether an emergency operation is necessary and, if so, to be sure there is no delay in performing it. My second goal is to ensure that additional tests are used appropriately and in a timely fashion to help make a dx. In those infants who will require an operation, I want to be certain to communicate to the family and members of the health-care team the risks, benefits, and alternatives of the recommended surgical tx plan and then to ensure that the operation proceeds as safely as possible.

PATIENT CARE

Clinical Thinking

- There are many causes of vomiting in infants and children. In the newborn, these conditions may be congenital, and surgical correction will be performed prior to discharge. In contrast, vomiting in older infants and children is usually due to acquired conditions and so the patient has likely been feeding at home for a period of time.
- Not all of the causes of vomiting in an infant will require surgical therapy.
- Some causes of vomiting are related to conditions that can have catastrophic consequences if not treated in a timely fashion.

History

- The most important determination is whether the emesis is bilious or nonbilious. Bilious vomiting is a surgical emergency and requires urgent evaluation.
- The age of the patient is important in determining the proper differential dx, regardless of the character of the emesis.
- The feeding hx provides clues to the differential dx. Determine if the patient has ever been able to feed without emesis.
- With nonbilious emesis, estimate the amount of emesis and its relationship to feedings.

Physical Examination

- General physical examination can provide clues to congenital abnormalities. For example, patients with esophageal atresia may have a heart murmur, limb abnormalities in the upper extremities, or anal anomalies as a part of VACTERL syndrome.
- A palpable epigastric mass is diagnostic in 3- to 6-week old infants with pyloric stenosis.

Tests for Consideration

- **Basic metabolic profile:** Will show the degree of hypochloremic metabolic alkalosis in pyloric stenosis or may show metabolic acidosis in the patient with dead bowel due to malrotation with volvulus. **$100**
- **pH probe:** Usually done over a 24-hour period and shows the presence and severity of gastroesophageal reflux. **$305**

IMAGING CONSIDERATIONS

→**Chest and abdominal x-ray:** Good starting point, minimal radiation. Look for distended esophagus, dilated upper GI tract. **$150**

→**Ultrasonography:** Fast, no radiation or sedation; can be performed in bassinet. Directly measures pyloric channel for stenosis. **$150**

→**Upper GI series:** Barium via feeding bottle outlines anatomy of upper GI tract. Minimal radiation when performed properly. **$225**

→**Gastric scintigraphy:** Radioisotope-tagged formula shows reflux and quantifies gastric emptying. **$500**

Clinical Entities — Medical Knowledge

Esophageal Atresia

Pφ Esophageal atresia is a spectrum of anomalies that may have an associated fistula to the tracheobronchial tree. The basic pathology common to the majority of cases is an upper esophageal segment or pouch that is not in direct continuity with the distal esophagus.

TP Difficulty swallowing saliva or inability to swallow the first feeding is the usual presenting sign. Prenatal dx is suspected with maternal polyhydramnios and absence of a fetal stomach bubble. In suspected cases, the presentation is inability to pass an orogastric tube.

Dx The dx of esophageal atresia is confirmed by placing an orogastric tube until resistance is met, injecting 5 to 10 cc of air into the tube, and taking a CXR to confirm an air-filled pouch that usually ends in the upper thorax. The presence of air in the GI tract on an abdominal x-ray will confirm the presence of a fistula to the tracheobronchial tree.

Tx The esophageal atresia is surgically corrected by mobilizing the two ends of the esophagus and creating an anastomosis. In about 85% of cases a fistula to the tracheobronchial tree is present and is ligated prior to sewing the esophagus together. The patient without a tracheoesophageal fistula will usually undergo initial placement of a gastrostomy tube for feeding. Further evaluation will determine the timing and choice of operations to repair the esophageal atresia. **See Sabiston 71, Becker 56.**

Bowel Atresias

Pφ Duodenal atresia is a failure of recannalization of the duodenum resulting in a duodenal obstruction. Jejunoileal atresia is an intestinal obstruction that results from a prenatal vascular accident that affects varying amounts of intestine.

TP The patient with duodenal atresia presents with vomiting after the first few feedings that may be bilious or nonbilious, depending on whether the atresia is proximal or distal to the ampulla of Vater. Patients with intestinal atresia present with bilious vomiting, failure to pass meconium, and progressive abdominal distention over the first day or two of life.

Dx The dx of duodenal atresia is suspected with early and vigorous vomiting and is supported by the presence of a "double-bubble" sign on abdominal x-ray. The dx of jejunoileal atresia is usually suspected by the hx and physical examination and is further supported by the presence of dilated bowel loops with air-fluid levels on abdominal x-ray. Limited upper GI contrast studies may be needed in either type of atresia if malrotation with a midgut volvulus is suspected. A contrast enema may be needed to confirm the dx of distal ileal atresia. A complete physical examination is done to determine associated anomalies (i.e., Down syndrome with duodenal atresia).

Tx Tx is surgery and involves creating an anastomosis between the ends of the intestine to achieve continuity of the gastrointestinal tract. **See Sabiston 71, Becker 57.**

Midgut Volvulus

Pφ Midgut volvulus is a condition associated with malrotation of the gastrointestinal tract and involves twisting of the bowel mesentery. This leads to duodenojejunal obstruction and/or vascular compromise of the affected bowel.

TP The typical presentation is bilious vomiting. Most will present within the first month of life. Children older than 1 year may present with abdominal pain. Early on, the abdominal examination is often normal.

Dx Bilious vomiting should prompt an immediate evaluation for possible malrotation. Abdominal x-ray may demonstrate a gasless abdomen or a double-bubble with distal bowel gas, or it may be unremarkable. Dx is confirmed by upper GI series, which demonstrates failure of the duodenojejunal junction to cross to the left of the vertebral column. Once the dx is made, the patient should be taken to surgery immediately.

Tx The surgical tx is Ladd's procedure. A transverse upper abdominal incision is made and the volvulus (if present) is reduced by twisting counterclockwise until it is untwisted. Ladd's bands are divided, the appendix removed and the small bowel is placed in the right side of the abdomen, and the colon is placed in the left side of the abdomen. **See Sabiston 71.**

Gastroesophageal Reflux Disease

Pφ Gastroesophageal reflux results when gastric contents reflux retrograde into the esophagus. Most infants have some degree of reflux due to the physiologic nature of the lower esophageal sphincter.

TP The typical patient presents with obvious discomfort with feeds, excess spitting or vomiting, arching, or feeding aversion with inadequate weight gain and failure to thrive. Older infants may have chronic cough or recurrent middle ear fluid. There may be recurrent microaspiration leading to chronic lung disease. Older children may have heartburn, hoarseness, recurrent sore throat, and episodic wheezing.

Dx A careful hx is taken to confirm nonbilious emesis. Nuclear medicine gastric emptying scan may demonstrate reflux, and will quantify gastric emptying. A pH probe is the gold standard test. Upper GI series is used to document normal anatomy. Severe cases may undergo upper endoscopy and biopsy to r/o eosinophilic esophagitis, usually caused by milk protein allergy.

Tx Medical therapy consists of H_2 blockers or proton pump inhibitors. Formula can be thickened for infants, and some physicians will add prokinetic agents. Indications for surgical therapy include failure of medical therapy and serious complications of their reflux such as recurrent pneumonia, apneic spells, esophageal strictures, or failure to thrive. A variety of different types of fundoplications can be performed, using either open surgery or laparoscopy. **See Sabiston 71, Becker 27.**

Pyloric Stenosis

Pφ Pyloric stenosis is an acquired hypertrophy of primarily the circular muscle of the pylorus, resulting in gastric outlet obstruction.

TP The classic presentation is a 3- to 6-week-old male infant with progressive nonbilious projectile vomiting. Frequently, several formula changes have been attempted without success. As the vomiting becomes more frequent and forceful, many infants lose weight. During vomiting, a reverse peristaltic wave can be seen crossing the abdomen.

Dx The dx is suspected clinically, and confirmed by either palpating a mass in the epigastrium that is typically the size and texture of an olive, or by ultrasonography demonstrating increased muscle thickness and/or an elongated pyloric channel. The classic "string sign" is seen on upper GI series, demonstrating pyloric obstruction. Progressive vomiting leads to hypovolemia and hypochloremic hypokalemic metabolic alkalosis.

Tx Initial tx is medical stabilization prior to operation. A 20-cc per kilogram bolus of normal saline is given and repeated until the child voids. Once the patient voids, intravenous fluid therapy is continued with dextrose-containing saline solutions that have potassium chloride added. These fluids are given at higher than maintenance rates until the patient's serum electrolytes are normal and adequate urinary output is established. Surgical tx is a pyloromyotomy and involves splitting the hypertrophic pyloric muscle to relieve the gastric outlet obstruction. **See Sabiston 71, Becker 57.**

ZEBRA ZONE

a. Intracranial space-occupying lesions such as hydrocephalus from intraventricular hemorrhage in a premature infant or subdural hematoma from shaken baby syndrome can present with vomiting due to increased intracranial pressure.

b. Inborn errors of metabolism or endocrine problems can cause vomiting. Congenital adrenal hyperplasia can cause vomiting due to potassium abnormalities.

Interpersonal and Communication Skills

Talking to Parents: Dealing with Anxiety Provoked by Technology
During the postoperative period, it is important to remember that family members are unaccustomed to all the technology associated with care in a modern neonatal ICU. Usually their bewilderment and anxiety can be reduced by a calm discussion explaining the function of each device and describing its role in the care of their child.

Professionalism

Commitment to Honesty with Parents
Some infants who require surgery for vomiting may have associated anomalies that are not compatible with a normal life. The spectrum can range from chromosomal defects such as Down's syndrome where the quality of life can be quite good to chromosomal defects that are uniformly lethal. Such chromosomal defects along with other associated anomalies (such as the VACTERL association) must be considered when formulating a tx plan.

Careful and sensitive multidisciplinary discussions must be held with the parents, taking care to be honest about what is known while being supportive of their needs and helping to guide them to a decision with which they can be comfortable. Many hospitals have ethics committees that can help facilitate these discussions.

Systems-Based Practice

Operations: Patient Identification and Patient Safety
Misidentification of patients is a major source of error: in the laboratory, with medication, in radiological procedures, in transfusion, and in surgical procedures. Accurate patient identification should be accomplished by matching two identifiers of the patient to two identifiers linked to the procedure. One identifier can be the patient's name, if the patient can articulate it. Do not address a patient by name and look for confirmation: "Are you Johnny Jones?" Rather, ask a patient: "What is your name?" or "Would you please give me your name?" For patients who cannot give their names and in the *pediatric* population, wristbands can be a source of patient identification information. The second identifier can be a birth date, address, telephone number, identification number (such as a medical record number), or labeled photograph, depending on what is available in the record. The procedure-linked identifiers should match both patient identifiers. Write notes and orders on the correct patient's record. Any binder and papers should each have the correct identifying information. Labeling laboratory specimens immediately at the bedside ensures a reliable match of patients to specimens. High-risk procedures, such as transfusions and operations, should be independently verified by two providers.

Chapter 66
3-Year-Old Female with a 12-Hour Onset of Abdominal Pain, Vomiting, and Fever of 38.5°C (Case 47)

Ruth D. Mayforth MD, PhD

Differential Diagnosis

Appendicitis	Intussusception
Mesenteric lymphadenitis	Gastroenteritis

Speaking Intelligently

My primary goal in evaluating a child with abdominal pain is to determine whether the child has a cause of pain that will require surgical therapy. If not, then I reassure the family and the referring physician that the pain will resolve, and carefully follow the patient to be certain that it does resolve. In some patients, additional testing is required, and I make certain that these tests are obtained in a timely fashion. If the patient has a condition requiring acute surgical therapy, I educate the family about the nature of the proposed procedure and assure that the patient is properly prepared for the procedure.

PATIENT CARE

Clinical Thinking

- It is important to recognize quickly the conditions that require emergent surgery to prevent major morbidity or death.
- A careful hx and physical examination remain the cornerstone of surgical assessment of the acute abdomen. When the patient is too young to provide a hx, it is obtained from parents or adult caregivers.
- An important first step is to reassure the patient and family that the examination will be performed gently. Distracting the patient during the physical examination may also be useful.
- If the patient has systemic manifestations of his or her illness, then dx may have to occur while management is initiated. For example, the hx can be obtained while IV fluid resuscitation is under way.

- The use of CT to evaluate patients with abdominal pain has become quite prevalent in adults (***see Chapter 11, Right Lower Quadrant Pain***). This may not, however, be the best practice in pediatrics. There is a risk for cancer secondary to the radiation of CT in children, especially if adult protocols are used.

History

- Determine the location, onset, duration, severity, and type of pain. Is it constant or episodic? Has the pain shifted in location?
- Fever, anorexia, and behavioral changes, including lethargy, should be noted.
- Ask about emesis, diarrhea, constipation, passage of flatus, or blood in the stools.
- Note any previous abdominal surgery.
- In adolescent girls, note menstrual and sexual hx.

Physical Examination

- A complete examination is performed looking for signs and symptoms of inflammation and hypovolemia (e.g., prolonged capillary refill). The examination should also include attention to nonabdominal conditions that can present as abdominal pain (e.g., streptococcal pharyngitis).
- A detailed abdominal examination includes identifying the point of maximal tenderness. When palpating, the surgeon's examination should begin away from the point of maximal tenderness and work toward tender areas. Focal peritoneal findings (tenderness to percussion, guarding, and rebound) may be present. Generalized peritonitis may present with more diffuse abdominal pain. In advanced peritonitis the abdomen is rigid.

Tests for Consideration

- **CBC:** A leukocytosis, especially with a left shift, suggests an inflammatory process. **$40**
- **U/A:** To r/o urinary tract infection, nephrolithiasis, or pyelonephritis. **$50**

IMAGING CONSIDERATIONS

→**Obstruction series:** Chest and abdominal x-rays infrequently show appendicolith (20%). Look for obstruction or free air, kidney, or gallstones. **$200**

→**Ultrasonography:** No radiation or oral contrast needed. False negatives occur. Also evaluate for kidney or gallstones, ovarian anthology. **$250**

→**CT:** Used rarely and judiciously in small children. Substantial radiation dose and long delay filling GI tract. **$800**

Clinical Entities — Medical Knowledge

Appendicitis

Pφ Appendicitis is inflammation of the appendix due to obstruction of its lumen, usually by an appendicolith or lymphoid hyperplasia. Progressive distention of the lumen of the appendix leads to ischemia, necrosis, and perforation.

TP Appendicitis typically presents with anorexia and acute onset of generalized periumbilical pain, which migrates to the RLQ. Pain is often followed by nausea and emesis, and often there is low-grade fever. With perforation, the patient will have either localized or generalized peritonitis and will be dehydrated and more ill appearing. Some children present with an intestinal obstruction from the inflammatory mass and abscess around the appendix. Children often have an atypical presentation, and many present after perforation.

Dx Early on, the WBC count may be normal or show mild leukocytosis. With progressive inflammation, there will be significant WBC elevation with a marked left shift. U/A may show a few RBCs or WBCs. With classic acute appendicitis, there is focal RLQ tenderness and peritonitis on examination. Ultrasonography can be useful, especially in thin young children or adolescent females. CT can be useful if the hx or physical examination is atypical, or for a prolonged hx if perforation is suspected to identify an abscess.

Tx Open or laparoscopic appendectomy. Recovery time is similar for either approach in younger children; adolescents recover more quickly with a laparoscopic appendectomy. In patients with a delayed presentation of perforated appendicitis, some surgeons will initially treat with a course of antibiotics and delay surgery. **See Sabiston 49, Becker 15.**

Intussusception

Pφ Intussusception is the invagination or telescoping of a part of the intestine into adjoining intestine. In children less than 2 years old, it is usually ileocolic without a pathologic lead point. Older children may have a pathologic lead point such as a Meckel's diverticulum.

TP Typical patients are 3 to 12 months old and present with episodes of severe abdominal pain with irritability and drawing up of their knees. The patients are often lethargic between episodes. Patients often present following a viral prodrome. The classic triad of colicky pain, vomiting, and bloody mucous stool (currant jelly stool) is relatively uncommon.

Dx A sausage-shaped mass in the RUQ may be palpable. Stool for occult blood may be positive. Obstructive series may be normal or may reveal a mass effect, usually in the RUQ with distended proximal bowel loops.

Tx A contrast enema is diagnostic and is therapeutic in 80% to 90% of cases. Contrast must be refluxed into the terminal ileum to ensure complete reduction. When an enema fails or if peritonitis is present, surgery is indicated. It may include simple manual reduction or resection of an identified lead point or necrotic bowel. **See Sabiston 71, Becker 57.**

Gastroenteritis

Pφ Gastroenteritis is caused by a number of common pathogens, including both viruses and bacteria.

TP The typical patient presents with vomiting followed by diarrhea. However, there may be only vomiting or only diarrhea. Stools may contain blood, more commonly with bacterial enteritis. Patients may have abdominal pain and signs of dehydration.

Dx A hx of sick contacts, travel hx, antibiotic use, and seafood ingestion should be obtained. The degree of dehydration should be assessed and serum electrolytes should be checked in severely dehydrated patients. Stools can be sent for analysis for fecal leukocytes, culture, and ova and parasites.

Tx Mild to moderate dehydration is managed with oral rehydration with Pedialyte, which can often be done at home. For severe dehydration, significant emesis or high stool output may prevent adequate oral rehydration, making IV rehydration necessary. Antibiotics may be indicated for patients with diarrhea due to *Clostridum difficile, Shigella,* or *Salmonella*.

Mesenteric Lymphadenitis

Pφ Mesenteric lymphadenitis is inflammation of the mesenteric (usually ileocolic) lymph nodes, and may be due to either bacterial or viral pathogens. It may occur with streptococcal pharyngitis, and in children is more commonly associated with a primary enteric pathogen.

TP The presentation is variable and may include fever, RLQ pain, anorexia, nausea, vomiting, and occasionally diarrhea. The site of tenderness may shift when the patient changes position (in contrast to appendicitis, where it usually remains in the same location). The patient may have pharyngitis.

Dx Leukocytosis is common. A throat culture for *Streptococcus* should be obtained if pharyngitis is present. The dx is generally one of exclusion. Ultrasonography with graded compression or CT may be useful in the dx and in excluding appendicitis.

Tx The disease is generally self-limited; hospital admission may be indicated for rehydration and for serial examinations to r/o an early appendicitis that may be missed on diagnostic imaging. **See Sabiston 43.**

ZEBRA ZONE

a. **Pneumonia:** Pneumonias (particularly lower lobe) may cause abdominal pain.

b. **Ovarian cyst or torsion:** Both of these can cause lower abdominal pain. Tx is usually cystectomy or detorsion and oophoropexy, respectively. **See Sabiston 75.**

c. **Meckel's diverticulitis:** The most common presentation of Meckel's diverticulum is of painless bleeding, but it can become inflamed and presents with signs and symptoms identical to appendicitis. **See Becker 57.**

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
The diagnosis of appendicitis in children: outcomes of a strategy based on pediatric surgical evaluation

Authors
Goldthorn JF, Lacey SR

Reference
Pediatrics 2004;113(1):29–34

Problem
Is the trend toward radiographic imaging as the gold standard for dx of appendicitis better than clinical evaluation by a pediatric surgeon with selective use of diagnostic imaging studies?

Intervention
Three pediatric surgeons developed an algorithm/protocol for the dx of appendicitis.

Comparison/control (quality of evidence)
Prospective, noncontrolled review of 356 children

Outcome/effect
This protocol, which relied on clinical evaluation and selective imaging, was 99% sensitive and 92% specific. It was more accurate (97%) than ultrasonography (82%) alone or CT (90%) alone.

Historical significance/comments
The results of this study showed that this protocol, emphasizing clinical evaluation with selective use of imaging, was highly accurate for the dx of appendicitis in children. Low rates of negative appendectomy and perforation were achieved without the costs and radiation exposure of excess imaging.

Interpersonal and Communication Skills

Talking to Parents: Dealing with Parental Guilt
Parents of children who have a perforated appendicitis may feel guilty about not having sought medical care prior to perforation. Others may have sought medical help and were given a dx of gastroenteritis, mesenteric lymphadenitis, or constipation and may feel upset that their children were misdiagnosed or guilty that they were not more persistent in seeking appropriate tx. In most cases, the parents can be reassured that, for a variety of reasons, children have a significantly higher perforation rate than adults and that they did nothing to worsen their child's condition.

Professionalism

Commitment to Improving Quality of Care: Arranging for Proper Follow-up is Essential to Improving Quality of Care
A patient may have real surgical pathology causing abdominal pain yet have a negative initial diagnostic workup. CT, for example, performed too early in the course of appendicitis may be falsely negative. It is important to advise the family that the surgeon remains available if symptoms change, persist, or worsen. An alternative may be a follow-up examination the following day by either the pediatrician or the pediatric surgeon. If there is concern that the parents may delay in seeking medical attention should the child's condition worsen, admission for observation may be the most appropriate action.

Systems-Based Practice

Patient Safety: Medical Errors, Simplifying Processes
Errors can occur at every step of medical care. One way to reduce errors is to reduce the number of steps, eliminating unnecessary steps. Another way to reduce errors is to add steps, adding redundancy in order to double-check critical information. Though diagnoses for patients with abdominal pain are made by physical findings, surgical diagnoses are often made by imaging studies or pathology reports. When surgeons make decisions about operating on patients, they must confirm the pathological findings themselves rather than relying on a verbal or written description. The value of a piece of information to the decision-making process can be determined by asking, "Would I make the same decision if this single piece of information were different?" If the answer is "No," the information should be verified before proceeding.

Chapter 67
4-Year-Old Boy with a Groin Mass (Case 48)

Barbara J. Pettit MD

Differential Diagnosis

Inguinal hernia	Hydrocele	Undescended and retractile testes	Testicular torsion (TT)
Testicular and paratesticular tumors	Epididymo-orchitis	Lymphadenopathy	

Speaking Intelligently

My approach to a child with a groin mass is determined by the acuity and severity of the presentation. My general approach to a child referred to the office for a routine evaluation is to determine if the child needs an operation, further evaluation, or simple observation. My goal in evaluating a child with the acute onset of a mass is to determine if the child needs an emergency procedure to relieve a bowel obstruction caused by an incarcerated hernia or to restore blood flow to a testicle whose blood supply has been compromised by TT.

PATIENT CARE

Clinical Thinking

- The child's age is an important factor in shaping a management plan. For example, my recommendations for tx of a hydrocele will be different in a 5-month-old versus a 5-year-old boy because of the different expectations for possible spontaneous resolution.
- Organs whose blood flow is compromised (bowel or an ovary strangulated in a hernia, or a torsed testis) have only a few hours before serious, possibly irreversible ischemic damage occurs. A dx must sometimes be made rapidly based on hx and physical findings alone, as there may not be time for diagnostic testing.
- Groin pathology may present as abdominal complaints and vice versa.

History

- Features of the general medical hx may help in determining the etiology of the mass. For example, inguinal hernias are more common in children with cystic fibrosis, connective tissue disorders, and children who have a ventriculoperitoneal shunt.
- The review of systems should focus on the presence of systemic symptoms such as fever and chills, abdominal symptoms such as pain, distention, nausea, emesis, and bowel changes, and genitourinary symptoms such as dysuria, frequency, and scrotal pain.
- A careful hx of the onset and course of a painless mass should be obtained. Particularly helpful are the following questions: How long has it been there? Does it come and go? If it does not come and go, is it staying stable in size or getting bigger or smaller?
- Similar questions should be asked about the acute, painful mass. In addition, ask about the onset, character, location, intensity, and radiation of the pain, as well as any drainage or hx of trauma.

Physical Examination

- The child's general demeanor should be assessed. Characteristics include degree of comfort and a general assessment of the patient's well-being.
- Signs of sexual development are particularly important in patients with painless scrotal masses.
- An abdominal examination is important, with particular emphasis on signs of bowel obstruction. These would include distention or tenderness.
- In boys, the genitalia are carefully examined beginning with the scrotum. The size and degree of rugal fold development are noted on both sides of the scrotum. Inflammatory scrotal changes are associated with TT, epididymo-orchitis, and incarceration of an inguinoscrotal hernia. Both testes are carefully palpated with attention to size and location. If the testes are not present in the scrotum, they may be palpable in the inguinal canals. The testes and

surrounding structures are carefully palpated for the presence of masses. The spermatic cord on each side is palpated to determine if it feels normal or tender.

- In girls, the external genitalia should be examined for the presence of ambiguity (e.g., clitoral enlargement or other evidence of masculinization). The location and character of a groin mass should be noted.

Tests for Consideration

- **U/A:** Sometimes helpful in evaluating the presence of epididymo-orchitis. $38
- **hCG stimulation test:** May be done to differentiate bilateral undescended testes (UDTs) from completely absent testes if both testes are impalpable. $50

IMAGING CONSIDERATIONS

➔**Color Doppler ultrasonography:** Performed when torsion is suspected but should not unduly delay an operation. $300

➔**Ultrasonography:** Can be helpful in distinguishing a cystic from a solid groin mass. $250

Clinical Entities — Medical Knowledge

Inguinal Hernia

Pφ In the male fetus, the testis descends into the scrotum from the retroperitoneum, dragging with it a tube of peritoneum called the processus vaginalis (PV). The lumen of the PV begins to close before birth and is generally obliterated by 1 year. In girls, the round ligament also passes through the inguinal canal. In patients with hernias, the PV fails to obliterate. If the PV remains open, abdominal contents may herniate into it, creating an inguinal hernia. A hernia incarcerates when the abdominal contents will not reduce, and strangulates when the blood supply to the incarcerated contents is compromised.

TP The patient or family member will note a mass in the groin area. It usually enlarges when the patient cries or coughs, as both maneuvers increase intra-abdominal pressure. With incarceration, the mass no longer spontaneously reduces. If intestine has incarcerated, the patient will present with signs of abdominal obstruction, including distention and bilious vomiting. A patient with an incarcerated ovary may present with an irreducible mass but few other symptoms.

Dx The dx is made if the mass completely disappears when the child is relaxed or reduces with gentle pressure. Asymptomatic incarcerated ovaries may not reduce, will be just outside the external ring, and are movable and regular in consistency. Incarcerated inguinal hernias cannot be manually reduced, and the mass may be tender and inflamed. If the mass is not present, but the hx suggests a hernia, the older child can be asked to take a deep breath and bear down.

Tx Tx for irreducible incarcerated bowel or a strangulated, incarcerated ovary is emergency exploration. Hernias that are not incarcerated, or, in the case of the incarcerated ovary, are asymptomatic, should be electively repaired at the earliest opportunity. Repair may be done via a small groin incision or laparoscopically. **See Sabiston 71, Becker 16.**

Hydrocele

Pφ Pathophysiology is similar to hernias. In the noncommunicating type, the PV obliterates from above but fluid has accumulated in the distal PV. In the communicating variety, the PV has failed to obliterate but the opening is so small that only peritoneal fluid can pass through the patent PV.

TP Children with communicating hydroceles present with a hx of a scrotal mass that increases in size when they are upright and active during the day, and is small or absent in the morning after sleep. Noncommunicating scrotal hydroceles present as painless masses that gradually decrease in size.

Dx The differentiation of communicating versus noncommunicating hydrocele is based on hx as neither is usually manually reducible. A scrotal mass that is irreducible, nontender, smooth, movable in the scrotum, and transilluminates is consistent with a hydrocele. The testis may be difficult to palpate if a scrotal hydrocele is large but will appear as a small shadow when the mass is transilluminated. The cord structures are palpable above the mass where they exit from the external ring.

Tx Noncommunicating hydroceles in the first year of life can be observed as most will close spontaneously. Those that fail to resolve after 1 year are corrected surgically. Communicating hydroceles at any age are repaired electively through a small groin incision. **See Sabiston 71, Becker 16.**

Retractile and Undescended Testes

Pφ In UDTs, the normal testicular descent is halted at some point from the area of the retroperitoneum just below the kidney where the testes originate down through the inguinal canal into the scrotum. The testes may be palpable in the canal but cannot be brought down manually into the scrotum. Retractile testes are normally descended testes that simply have a vigorous cremasteric reflex and can be brought down manually into the scrotum.

TP Children with both retractile and undescended testes may present with a small, nontender, regular, movable mass in the groin or at the top of the scrotum. The condition may be unilateral or bilateral.

Boys with retractile testes will present with a history that the testis was in the scrotum in contrast to those with UDT, where the testis has never been observed to be in the scrotum. It is possible to manipulate the testes into the scrotum in children with retractile testes, but this is not possible in UDT.

Dx UDTs are often accompanied by a small, flat scrotum on the affected side(s), and there is no hx of the testis having been seen in the scrotum. If testes are not palpable bilaterally, an hCG stimulation test should be done to determine if there is functioning testicular tissue.

Tx The tx of retractile testes is reassurance and observation. Orchiopexy is done for patients with UDTs to preserve fertility, improve appearance, and allow for surveillance for testicular tumors. Depending on the location of the testes, this can be done through an inguinal incision or using laparoscopy in one or two stages. **See Sabiston 71, Becker 57.**

Testicular Torsion

Pφ The peak incidence of TT occurs in adolescence and is due to an anatomic variant referred to as a “bell clapper deformity.” The tunica vaginalis wraps around the testis and inserts high on the cord structures. This predisposes to twisting, which can lead to torsion.

TP Usually sudden onset of severe testicular pain, although occasionally boys present with a more gradual onset of less severe pain, which confuses the dx. The scrotum is swollen and tender.

Dx Prior to the acute episode, there may be a hx of recurrent, short episodes of testicular pain. Often, there is associated abdominal pain, nausea, and emesis. The testis and epididymis are swollen and tender, and may be surrounded by an overlying reactive hydrocele and scrotal edema. The testis may assume a horizontal orientation in the scrotum, and the spermatic cord will be shortened. Ancillary diagnostic studies should only be considered if time will permit as testicular necrosis will occur in a few hours after onset of torsion has occurred.

Tx Immediate surgical exploration is performed through a scrotal incision and the testis is detorsed. If blood flow is restored or there is a chance of viable parenchyma, orchiopexy is performed. A testis that is necrotic and nonviable is removed. Because the anatomic abnormality exists on the opposite side, orchiopexy of the uninvolved, contralateral side should also be performed at the same time. **See Sabiston 71, Becker 57.**

Lymphadenopathy

Pφ Lymphadenopathy in the groin may be reactive, due to an infectious or inflammatory process in the perineum, buttocks, or lower extremities, or may be part of diffuse adenopathy secondary to a systemic infectious, inflammatory, or neoplastic disease.

TP An immobile mass in the groin is palpable or visible above the inguinal ligament. The mass may or may not be tender. Consistency is usually firm and “rubbery” and may feel like a cluster of several smaller masses close together. The mass may have been present for several weeks. If acutely infected, there may be erythema and tenderness, with edema of the overlying skin, fluctuance due to undrained pus, or active drainage of pus. A hx of infections (e.g., infected insect bites) or skin lesions in the perineum, buttocks, and lower extremities may be elicited.

Dx Isolated inguinal adenopathy (<1.5 cm diameter) without acute infection generally requires no further studies. Generalized adenopathy should prompt workup for systemic conditions (e.g., generalized infections).

Tx Isolated, noninfected inguinal adenopathy may be observed for 1 to 2 months to see if resolution occurs. If it fails to resolve, then biopsy should be considered. Infected inguinal lymph nodes should be treated with antibiotics and incision and drainage if fluctuance is present.

Testicular and Paratesticular Tumors

Pφ Primary tumors of the testis arise from the germ cells and the stroma. Tumors may also arise in the supporting testicular structures and from leukemic infiltrates. Paratesticular rhabdomyosarcoma occurs outside the testis but is included in the differential dx of a solid scrotal mass. Benign lesions resembling testicular tumors may also occur.

TP A tumor may present as a solid, painless mass in the scrotum or along the cord structures within or above the scrotum. With hormone-producing tumors, precocious puberty ensues.

Dx Testicular ultrasonography if the dx is in question or a solid component within an existing hydrocele is suspected. U/A is normal. A chest radiograph and serum tumor markers (α-fetoprotein and β-hCG) should be obtained preoperatively if tumor is suspected.

Tx Radical orchiectomy is performed via an inguinal incision. Further therapy (e.g., chemotherapy, radiation therapy) is dictated by the type and stage of the tumor. **See Sabiston 71, Becker 61.**

ZEBRA ZONE

a. Testes in girls: 3% to 5% of inguinal hernias in girls will contain an abnormal gonad in the hernia sac, most often a testis in a child with testicular feminization syndrome.

b. Torsion of a testicular appendix: This condition occurs secondary to torsion of one of the many small vestigial appendages attached to the testis. The infarcted appendage may be visible through the scrotal skin as a blue or black dot (the "blue dot" sign). **See Sabiston 77.**

Interpersonal and Communication Skills

Talking to the Pediatric Patient

Communicating with very young patients presents certain challenges and rewards. When working with children, remember to give age-appropriate information, using common terms and language, about the reason for the operation. Explain, step-by-step, the course of perioperative events. School-aged children often associate doctors and medical procedures with "shots." In most institutions (you should be familiar with the protocols in yours), preoperative laboratory studies are unnecessary in healthy children undergoing elective outpatient surgery, and IV lines are initiated only after a preoperative oral or rectal sedative and mask anesthetic induction. It is possible, therefore, to tell children that there will be no shots. Reassure children that if there is any soreness in the area of the operation, their parents will have medicine that will take care of it. Ask children about their activities: your idea of "taking it easy" for a week may be different from that of an 8-year-old boy, who may consider doing wheelies on his bike "taking it easy." Programs that allow children and their parents to tour the operative facility preoperatively are helpful in allaying their fears. Several books and videos that describe the general perioperative experience in age-appropriate ways are also available.

Professionalism

Commitment to Improving Quality of Care: Balancing Diagnostic Certainty and Early Consultation

In today's medical practice the use of technology and the "need to be sure" can translate into an inordinate delay in the dx of an incarcerated inguinal hernia or testicular torsion. While the level of diagnostic certainty might be increased by a trip to the radiology or nuclear medicine department, the clock is ticking for structures whose blood supply is in jeopardy. As uncomfortable as it may be, the clinician caring for a patient may only be certain that the dx is uncertain. Rather than consuming time with further observation and/or testing, a physician must be comfortable calling a colleague early to say, "I am unsure, but I believe early consultation is important." Conversely, physicians (and residents!) should be receptive to seeing consultations that are requested even before basic tests are performed.

Systems-Based Practice

Creating a Patient-Centered Environment

Most operations in children such as repair of inguinal hernias and hydroceles are performed on an outpatient basis. Most children come to the operation healthy: they do not require preoperative screening labs or radiographic studies or perioperative antibiotics, and complication rates for outpatient surgical procedures are low. Pediatric outpatient surgery requires the provision of an environment that is patient- and family-friendly, with medical and nursing staff who are familiar with the psychological and physiologic needs and differences of each age group.

Chapter 68
2-Year-Old Boy with Gastrointestinal Bleeding (Case 49)

Donald R. Cooney MD

Differential Diagnosis

Polyps	Peptic ulcer disease	Anal fissure
Meckel's diverticulum	GI duplication	Inflammatory bowel disease

Speaking Intelligently

GI tract hemorrhage may be relatively inconsequential or may be associated with a life-threatening condition. When I am asked to see any child who has bleeding from the GI tract, I treat it as a potentially urgent problem and begin by considering the most common causes of bleeding for a child of that age. Next I determine by physical examination and laboratory tests if I am dealing with a potentially life-threatening condition that may require immediate surgical tx. For less acute bleeding, my goal is to be certain that all appropriate testing is done so that I can determine whether or not surgery is indicated. Finally, if surgery *is* indicated, I need to select the best surgical option for this particular child.

PATIENT CARE

Clinical Thinking

- Bleeding in any child can be a self-limiting condition, easily treated, or a serious life-threatening problem.
- Physical examination, simple laboratory tests, and x-rays will, in many cases, establish the dx and allow for expeditious tx.
- Consideration of the differential dx of GI hemorrhage begins with consideration of the child's age. Common causes of bleeding in newborns include necrotizing enterocolitis, swallowed maternal blood, coagulopathy, and midgut volvulus. Common causes of GI bleeding in children ages 2 to 8 years include polyps, Meckel's diverticulum, GI duplication, and peptic ulcer disease. Bleeding in older children is more commonly from esophageal varices, polyps, Meckel's diverticulum, and inflammatory bowel disease.

History

- Remember that common causes of bleeding vary according to the age of the child.
- For newborns, the obstetrical hx should focus on the possibility that the infant may have had a stressful birth and potentially swallowed maternal blood. Duration and severity of the bleeding are important, as are the relationship of bleeding to other events (i.e., lack of stooling and vomiting suggests midgut volvulus or intussusception, while rapid and voluminous bleeding is more indicative of a peptic ulcer or a Meckel's diverticulum).
- Always check family hx for disorders that may cause bleeding, such as hemophilia or other coagulation abnormalities.
- Melanotic stools are usually a sign of bleeding from the upper GI tract, while bright red bleeding is more indicative of lower GI tract hemorrhage.
- A presence of other known medical conditions such as esophageal varices, peptic ulcer disease, or the taking of medications such as NSAIDs may provide a clue to the source of bleeding. The presence of liver disease may suggest esophageal varices, which are otherwise quite uncommon.

Physical Examination

- First determine the presence or absence of shock. Appropriate resuscitation should take precedence over the investigation of the source of GI bleeding.
- A complete physical examination may reveal clues of an underlying condition causing the bleeding. For example, the presence of dark pigmented lesions in the oral mucosa may suggest Peutz-Jeghers polyposis.
- The abdomen should be inspected and carefully palpated. Some conditions that cause GI bleeding are associated abdominal distention and peritonitis late in their course. Examples are midgut volvulus and intussusception.
- Careful evaluation of the anus and rectum may provide substantial information as to the source of bleeding (e.g., fissure, polyps).
- An NG tube and suctioning of gastric contents can help determine if the bleeding is proximal to the ligament of Treitz or more distal (i.e., upper GI bleeding vs. lower GI bleeding).

Tests for Consideration

- **Hemoglobin level:** Allows for a determination of the severity of the bleeding. With brisk acute bleeding, the hemoglobin may not immediately reflect the true extent of blood loss. **$38**
- **Coagulation profile:** Coagulation disorders are a rare cause of GI bleeding in children, but massive bleeding can cause coagulation abnormalities that may need preoperative correction. **$80**
- **Stool hemoccult:** To determine presence of occult blood. **$50**

IMAGING CONSIDERATIONS

➔**Abdominal x-ray (AP supine view):** For air in the wall or portal venous system of the liver.	$150
➔**Contrast enemas:** Rarely used. Replaced by endoscopy.	$250
➔**Meckel's scan:** Gastric mucosa normally accumulates radioactive isotope. Will also accumulate in ectopic mucosa of Meckel's diverticulum.	$500

Clinical Entities — Medical Knowledge

Gastrointestinal Polyps

Pφ Young children and toddlers can have juvenile or inflammatory polyps. These are thought to be caused by an inflammatory process that gradually increases over time as the peristalsis drags the inflammatory mass into the lumen of the colon. Other polyps are associated with chromosomal and genetic abnormalities, including Peutz-Jeghers disease, familial polyposis of the colon, juvenile polyposis of the colon, and Gardener's syndrome.

TP Colonic and intestinal polyps often present with intermittent episodes of hematochezia, which can be dark red or bright red. Occasionally there is severe bleeding, which can impact hemodynamic stability.

Dx The dx of polyps is made on physical examination of the rectum and by sigmoidoscopy or colonoscopy. A contrast study may be helpful, particularly for small bowel polyps as seen in Peutz-Jeghers syndrome. Often, rectal polyps can be visualized on a simple rectal examination.

Tx The most important consideration is to determine the pathology of the polyp. After the polyp is removed, a careful examination of the colon is always indicated. The histological nature of the polyp is determined after it is removed, checking for a genetic or precancerous dx. Multiple polyps raise the possibility of a genetic syndrome. In adenomatous polyposis of the colon and other polyposis syndromes the patient will require monitoring and possible removal of the premalignant colonic mucosa. Almost all polyps can be removed by sigmoidoscopy or colonoscopy. **See Sabiston 50; Becker 21, 26.**

Meckel's Diverticulum

Pφ Meckel's diverticulum is a remnant of the omphalomesenteric duct that originally connected to the embryonic yolk sac. It is present in approximately 2% of the population. It is usually located on the antimesenteric side of the intestine, approximately 2 feet from the ileocecal valve. Ectopic tissue, including pancreatic tissue, colonic tissue, and particularly gastric mucosa, may be present. Of most significance is the ectopic gastric mucosa, which secretes acid and may cause an ulcer in the adjacent small bowel mucosa, which predisposes to hemorrhage.

TP The bleeding with Meckel's diverticulum is usually severe and painless. The mean hemoglobin has been reported to average from 7 to 8 g. It tends to cease spontaneously, which allows for a careful evaluation of the source of bleeding.

Dx The dx is made by a careful hx, noting a sudden onset of painless and massive bleeding. Insertion of an NG tube usually r/o the upper GI tract as the source. If the bleeding is coming from the lower GI tract, a lower endoscopy is indicated. If the bleeding source is not identified, the child is stabilized and a technetium scan searching for an area of ectopic gastric mucosa usually establishes the dx.

Tx A bleeding Meckel's diverticulum should be removed after the patient has been stabilized. It is unusual to have to operate emergently, although this may be necessary if the bleeding continues. The Meckel's diverticulum is excised, ensuring that all of the ectopic gastric mucosa has been removed. Surgery is curative. **See Sabiston 48, Becker 57.**

Inflammatory Bowel Disease

Pφ The etiology of both Crohn's disease and ulcerative colitis is unknown. Evidence is accumulating that both diseases occur as a result of both genetic and environmental factors. Crohn's disease can be present throughout the GI tract and results in transmural involvement of the affected area. Ulcerative colitis is typically confined to the colon, although it can have extraintestinal manifestations.

TP Children with Crohn's disease are often underweight for their age. Perianal ulcers are a strong clue that this disease is the source of the GI bleeding. Patients with ulcerative colitis may also show signs of chronic malnutrition (e.g., underweight, delayed sexual maturity). The GI bleeding with both of these conditions may be significant but is usually chronic in nature.

Dx There are radiologic features associated with both of these conditions that provide additional evidence for the dx. Dx is usually confirmed through esophagogastroscopy or colonoscopy with biopsy. Endoscopy is also used to identify the location of bleeding prior to surgical intervention.

Tx Medical therapy for inflammatory bowel disease involves a variety of anti-inflammatory and immunosuppressant medications. Surgery for Crohn's disease is indicated in patients who do not respond to medical therapy. Surgical therapy for GI bleeding from ulcerative colitis usually involves a total colectomy and ileostomy with reconstructive surgery done when the patient is stable. **See Sabiston 48, 50; Becker 22.**

Gastrointestinal Duplication

Pφ Duplications of the GI tract are congenital abnormalities of the bowel that can be spherical or cylindrical. Most will have a communication with the GI tract and are located on the mesenteric side of the bowel. If they contain gastric mucosa, the secretions may cause mild to moderate bleeding from an ulcer in the adjacent mucosa of the small bowel, stomach, duodenum, or colon. Rarely, severe bleeding may occur.

TP Abdominal pain and frequent stools containing dark red or tarry stools are characteristic findings.

Dx A technetium scan is the most effective preoperative diagnostic test. Occasionally an upper GI series with small bowel follow-through may identify the duplication.

Tx Removal of the duplication is the preferred tx. This requires a resection of the involved portion of bowel.

Anal Fissure

Pφ The cause is often a change in diet from formula or breast milk to more solids, causing a thickening and sometimes hardening of the stool. Many times this is a direct result of introducing table food into the diet, although anal fissures do occur in newborns. Constipation and stool withholding are common contributing factors in toddlers and older children. Stooling is quite painful with a fissure, as the sensory nerves in the anus are quite sensitive to stretch during defecation. Child abuse may need to be considered. A dx of child abuse must be r/o by a careful hx and examination of the infant, looking for other signs of abuse.

TP The typical presentation of anal fissure is of an infant who has straining at the stool, pain during defecation, and red streaking of small amounts of blood in the stool or on the diaper.

Dx The dx of a fissure is made by inspection. A sentinel tag of skin may be present at the site of the internal fissure. Constant gentle anal pressure will in most cases evert the anal mucosa to visualize the fissure. Use of a glass test tube or nasal speculum inserted gently into the anus may be of help in identifying the fissure.

Tx The tx consists of adding fiber to the diet and altering the diet so that the child doesn't become chronically constipated. Adequate fluid intake should also be assured. Stool softening agents minimize pain and help promote more complete evacuation. **See Sabiston 51, Becker 21.**

Peptic Ulcer Disease

Pφ The etiology of peptic ulcer disease may be related to other conditions such as burns, trauma, malignancy, or sepsis. In addition, the child may have been taking salicylates or NSAIDs. Children infected with *Helicobacter* are more prone to develop peptic ulcer disease.

TP Although patients with peptic ulcer disease may pass blood in their stool, these patients usually pass larger amounts of blood than children with intussusception or polyps. Many times the bleeding can be relatively severe and cause hemodynamic instability.

Dx A patient with peptic ulcer disease can be relatively easily differentiated from a child with bleeding from the lower GI tract by placement of an oro- or nasogastric tube. In addition endoscopy is indicated in most cases to determine the exact nature and location of the bleeding as well as to potentially treat the bleeding ulcer or visualize the extent of the gastritis.

Tx Most patients with peptic disease can be treated by medical means. Acute bleeding usually does not continue, and tx with acid-suppressive medications usually suffices to treat the upper GI tract hemorrhage. Rare patients who continue to bleed may require endoscopic coagulation of the bleeding areas. In unusual cases an operation to ligate the bleeding vessel in the duodenum or stomach may be a life-saving measure. **See Sabiston 46, Becker 26.**

ZEBRA ZONE

a. **Swallowed maternal blood:** The infant can swallow maternal blood in the birth canal, and will present with upper GI bleeding. The Apt-Downey test, which differentiates between the infant's and mother's blood, is used to confirm this dx.

b. **Hemolytic uremic syndrome:** This is one example of a systemic illness that can complicate severe pneumonia or gastroenteritis, and can include gastrointestinal bleeding.

Practice-Based Learning and Improvement: Morbidity and Mortality Self-Assessment Form	
Complication	Bleeding after resection of Meckel's diverticulum
Type	Error in judgment; preventable
Surgery performed	Laparoscopic resection of Meckel's diverticulum
Patient's disease	Meckel's diverticulum
Presentation	Rectal bleeding after surgery noted on POD #2
Intervention	Return to OR for resection of the affected segment of bowel
Outcome	Patient recovered uneventfully after the second surgery and was discharged home.
Risk factors	Presence of disease
How were risks addressed?	The risk for bleeding was mentioned to the family during the informed consent process.
What happened?	The intestinal bleeding was from an ulcer adjacent to the Meckel's diverticulum. It was not resected in the first procedure.
What could have been done differently?	The diverticulum and adjacent bowel could have been pulled through one of the trocar sites to allow the area around the diverticulum to be inspected directly.

Would outcome have been different?	Return to the OR would have been avoided, and the hospitalization would probably have been shorter.

Interpersonal and Communication Skills

Talking to the Pediatric Patient

Families of children with GI bleeding are always extremely anxious and concerned about the serious nature of the condition that might exist. It is therefore particularly important that the doctor reassure the family that the bleeding will be controlled and will not result in any further complications for their child.

Talking to a young child can be challenging. It is important to establish a rapport with the child by speaking directly to him or her with limited parental involvement, projecting a kind, gentle, and friendly demeanor. Literally, avoid talking *down* to the child; *sitting* will put you closer to eye level with your small patient and is less intimidating for the child. Try not to talk about signs and symptoms until you have established some minimal relationship. This approach is usually applicable in children 2 years of age and older. Often speaking to the child about his or her pets, siblings, or a toy the child has in his or her bed will get the conversation started off in the right direction.

Professionalism

Commitment to Professional Responsibilities: Teamwork, Respect for Others

In cases of GI bleeding, a number of physicians may be called to the bedside and they may offer different opinions regarding dx and tx. It is important to recognize that a variety of modalities may be utilized to establish the dx and that there may be various therapies available for each individual condition. A consideration of the opinions of all those involved in the case will result in better care and improved rapport with the family. It is appropriate to discuss the various diagnostic and tx options with the family but at the same time to offer reassurance for whatever final plan of action is decided on.

Systems-Based Practice

Personal Empowerment within the Operating Room
Patients in the OR are at risk not only for bleeding, infection, and inadvertent enterotomies but also for incorrect operations, retained foreign bodies, and burns from fires from the use of electrosurgery in an oxygen-rich environment. The safest teams are those in which every member of the team understands pertinent patient issues (e.g., allergies) and the goals of the procedure and feels empowered to watch for mistakes and to speak up about such concerns in a direct manner.

Chapter 69
Abdominal Mass in a 4-Month-Old Infant (Case 50)

Douglas Katz MD

Differential Diagnosis

Wilms' tumor	Hepatoblastoma
Neuroblastoma	Hirschsprung's disease

Speaking Intelligently

Many children are identified as having an abdominal mass, and often their families and referring physicians are worried that it may be malignant. My primary goal in the evaluation is to determine whether or not the mass is malignant and then identify the appropriate surgical tx. A complete hx and physical examination is performed at the outset. In addition to providing important clues as to the exact dx, a thorough initial evaluation demonstrates to the family that I am taking this problem very seriously and helps alleviate parental anxiety.

PATIENT CARE

Clinical Thinking

- The majority of children diagnosed with an "abdominal mass" do not need surgical intervention. A significant number of children will have constipation or a distended bladder confused with a more serious problem.
- Favorable outcomes and the avoidance of complications often depend on a timely, accurate dx.

History

- When the mass was first noted and any changes in the size are important information.
- Patients with neuroblastoma often have bone marrow involvement. Anemia will cause them to have less energy and more fatigue.
- Time of first passage of meconium and the subsequent stool pattern are essential information when evaluating for Hirschsprung's disease.
- Hematuria, occult or frank, often with no hx of trauma, may be the presenting sign of a renal tumor.
- A family hx of Hirschsprung's disease is very important.
- Regression in motor function milestones could indicate invasion of neuroblastoma into the spinal canal.

Physical Examination

- Location, size, and mobility of the mass should be noted.
- Significant hypertension and tachycardia may suggest a vasoactive tumor.
- Neuroblastoma is associated with a number of unique physical findings. Metastatic disease to the skin will appear as small blue nodules. Neuroblastoma can also metastasize to the orbits and create dark circles around the eyes in a pattern that has been described as "panda" eyes. Neuroblastoma can cause opsomyoclonus, which is characterized by myoclonic jerking and a pattern of nystagmus that is called "dancing-eye syndrome."

Tests for Consideration

- **α-Fetoprotein:** Very sensitive for hepatoblastoma (70%–90%). **$100**
- **U/A:** Hematuria suggestive of Wilms' tumor. **$18**
- **CBC:** Anemia is more common with neuroblastoma than with the other tumors. **$38**
- **Urine catecholamines:** Elevations may suggest a dx of neuroblastoma. **$50**

IMAGING CONSIDERATIONS

➔**Abdominal x-ray (AP supine view):** Look for constipation or abdominal mass (e.g., microcalcificatons of a neuroblastoma).	$156
➔**Contrast enema:** Barium or water-soluble contrast shows clonic anatomy. Look for narrowed transition of Hirschsprung's disease.	$250
➔**Ultrasonography:** Fast, easily obtained in infants. Should define mass and site of origin; cystic or solid and vascularity.	$225
➔**CT:** Rarely used in infants.	$800
➔**MRI:** No radiation. Occasionally used for operative planning to evaluate extent of tumor, vascular invasion, and staging.	$900

Clinical Entities — Medical Knowledge

Wilms' Tumor

Pφ Wilms' tumor or nephroblastoma is a diverse group of malignant neoplasms of renal cell origin (nephroblasts). There is marked compression of the normal kidney and may be obstruction of the collecting system.

TP Most often diagnosed as an asymptomatic abdominal mass in children usually less than 15 years of age. May also present with microscopic or gross (occasionally with minimal trauma) hematuria. Tumor occlusion of the left spermatic vein may produce a left varicocele. Often, the parents note abdominal asymmetry while bathing the child.

Dx There are no specific blood or urine tests for Wilms' tumor. CT is the main imaging study, though MRI is also very sensitive. Ultrasonography and MRI are useful in detecting vascular involvement.

Tx Surgical excision and staging are the main elements of therapy. Biopsy of nonresectable lesions, followed by chemotherapy and often radiation therapy, is eventually followed with surgical resection of remaining tumor. Additional chemotherapy and radiation therapies depend on the stage of tumor. Partial nephrectomy is usually only performed in cases of bilateral disease. **See Sabiston 71, Becker 58.**

Neuroblastoma

Pφ A tumor of neural crest origin with a widely variable course, ranging from benign maturation and spontaneous regression to widespread metastatic disease. Its cause is unknown. May occur anywhere along the course of the sympathetic chain, most often arising in the adrenal medulla.

TP The majority of patients are diagnosed by 10 years of age. Often presents as a painful, hard, immobile abdominal mass. Weight loss and fever are common, with 25% having hypertension. Other symptoms are dependent on the location of metastases (common), and the production of vasoactive substances.

Dx 24-hour urine specimens have marked elevation in catecholamines and metabolites in most patients. Plain abdominal x-rays will demonstrate stippled calcifications in half of patients. CT and MRI are the imaging studies of choice, and will aid in the dx of metastases. Biopsies are essential, and samples must be of adequate size to allow for multiple biologic and genetic studies.

Tx Tumor excision for low-risk tumors is often curative and is still an important component in the tx of the majority of other cases. Intense chemotherapy is used for most patients, with radiation therapy and bone marrow for the most severe of cases. **See Sabiston 71, Becker 58.**

Hepatoblastoma

Pφ Arises from a precursor of the mature hepatocyte, usually with expression of different cell types. The cause is not known, but it is often seen in association with genetic syndromes. Usually presents as an expanding solitary mass. Spontaneous focal necrosis is common, and spread via hepatic veins, most often to the lung, is not uncommon.

TP Most often seen as an asymptomatic abdominal mass in infants or very young children. Abdominal pain, weight loss, nausea, and vomiting may be seen in advanced disease.

Dx Marked elevation in α-fetoprotein is seen in nearly 90% of patients. CT and MRI most accurately define the tumor and help determine resectability. Scans of the chest and brain determine metastatic disease.

Tx Initial resection is possible in only 50% of patients. Biopsy is followed by chemotherapy, which is usually very successful in shrinking the tumor. Definitive resection involves a lobectomy or trisegmentectomy. Liver transplantation is used for unresectable tumors with no metastatic disease. **See Sabiston 71, Becker 58.**

Hirschsprung's Disease

Pφ Absence of ganglion cells in the distal bowel leads to an inability of the bowel to relax and allow passage of stool. While the exact cause is not known, it is occasionally associated with other genetic conditions.

TP While the dx may occur at any age, most children with constipation since birth, or who failed to pass meconium within the first 2 days of life, should be suspected of having Hirschsprung's disease. Most cases are now diagnosed within the first 6 months of life. Children can present with constipation, failure to thrive, abdominal distention, and enterocolitis.

Dx Prone cross-table lateral abdominal x-rays may demonstrate absence of distal colonic and rectal air. A contrast enema may demonstrate a transition zone, which is seen less commonly in newborns. Rectal biopsy is the gold standard and may be done at the bedside in infants. It reveals the absence of ganglion cells and the presence of hypertrophied nerve trunks.

Tx The normally innervated bowel is brought closer to the anus using a variety of different surgical techniques. Recently, these procedures have been performed using minimal access techniques or transanally. In some cases, the correction can be done in a single procedure, although in some cases it is preceded by the creation of a colostomy or ileostomy done in the normal bowel. **See Sabiston 71, Becker 57.**

ZEBRA ZONE

a. **Hydronephrosis and multicystic kidney:** Hydronephrosis may result from obstruction of the ureter-pelvic junction, ureter-vesicular junction, or a bladder outlet obstruction and can be bilateral. Sonography shows a dilated renal pelvis surrounded by and connected to dilated cystic calyces.

b. **Stool collections:** Children with functional constipation can develop remarkably large stool collections that are palpable through the abdominal wall.

c. **Ovarian tumors:** These tumors are rare in girls but can become quite large. When they are large they can present as lower abdominal masses. **See Sabiston 71.**

Practice-Based Learning and Improvement: Morbidity and Mortality Self-Assessment Form

Complication	Ruptured nephroblastoma
Type	Error in technique; preventable
Surgery performed	Radical nephrectomy
Patient's disease	4-month-old male infant with nephroblastoma
Presentation	Rupture of tumor during nephrectomy
Intervention	None
Outcome	Patient now has a more advanced stage of disease and will require abdominal radiation and more intensive chemotherapy.
Risk factors	Large tumor
How were risks addressed?	Attempts were made to handle the kidney carefully.
What happened?	The tumor was being retracted by one surgeon while the other surgeon dissected it from the surrounding tissue. As the tumor was being manipulated, the capsule split, and tumor and blood filled the surgical field.

What could have been done differently?	A larger incision could have been made so that less pressure was applied to the tumor. The surgeon should communicate to the anesthesia team that complete muscle relaxation is imperative. Finally, the pressure on the tumor can be distributed by spreading widely apart the fingers of the hand being used to retract the tumor.
Would outcome have been different?	If the tumor had not ruptured, the intensity and duration of the chemotherapy would have been less and radiation might have been avoided. Survival may also have been affected adversely.

Interpersonal and Communication Skills

Dealing with the Fear of Unknown Outcome
The initial discussion with the family of a child with an abdominal mass may be very difficult as there is a wide range of possible conditions requiring markedly different treatments and the level of fear and anxiety will be very high. Explaining the broad range of outcomes and expectations is daunting. As some of the etiologies may be lethal, it is important to stress that there are very good treatments for many of the conditions and that outcomes have improved over the years. Take care to assure the family that you will work very closely with them to find the medical answers and develop the best possible tx plan for their son or daughter.

Professionalism

Commitment to Professional Responsibilities: Dealing with Perceived Delay by Another Medical Professional
It is often the case that a child with an abdominal mass has a real or perceived delay in dx. This perception is often a cause for feelings of guilt for parents and primary care physicians. It is critically important to avoid assigning blame to anyone and to focus on the positives. A sense of trust and respect must be maintained for all involved in the child's care.

Systems-Based Practice

Business Skills: Balancing Professional and Practice Life

As the only pediatric surgeon in the community, you have just returned home after a tough day and night on call. During this period you operated on a patient with a Wilms' tumor, another with a tracheo-esophageal fistula, and two with inguinal hernias. You also performed appendectomies on two patients who had come to the emergency department. For you, sleeping, eating, and relaxing are on your mind. To your family, mom (or dad) is coming home.

How to be a mother, father, husband, wife, or partner *and* a great doctor is not a trivial discussion. Surgical practice consumed the lives of many baby-boomer surgeons. Unfortunately, that philosophy brought record divorce rates, unfulfilled parenting roles, and a generation of some unhappy surgeons. There is no one lesson for helping you maintain balance in your life, but making that balance must be a priority. Are you spending too much time at work and getting testy with your family? Are you canceling or postponing family events and rationalizing your absence? Or, have you overcompensated and found that you have not been to a continuing education session or read any journals in months? Take time to find out what others need and want from you. Recognize that your colleagues and significant others may also face challenges in personal and professional balance. Write down your priorities and make a plan for meeting personal and professional goals. Review and revise your plan monthly.

Have you had the opportunity to evaluate a pediatric surgical patient? How good was your communication with the patient? . . . with the family? Consider reviewing your patient's course in the context of the Competency Self-Assessment Form on page 35, which can also be found as a Word document on the book's Web site at www.studentconsult.com, from which it can be printed or downloaded for your patient-encounter portfolio.

Professor's Pearls: Pediatric Surgery

Section Review

Consider the following clinical problems and questions posed. Then refer to the professor's discussion of these issues.

1) A newborn girl is born 4 weeks prematurely with several loops of intestine protruding through a small defect to the right of the umbilicus. The intestine appears thickened and there is an obvious blind-ending loop visible.
What is the dx? What are your most immediate concerns? What problem is this patient likely to encounter during her hospital course?

2) An infant born at 37 weeks' gestation requires immediate intubation due to profound respiratory distress. Despite aggressive ventilatory and medical support, he is acidotic with poor perfusion. The abdomen appears scaphoid.
What is the likely dx and how can it most readily be confirmed? What are the most important steps in the initial tx of this infant?

3) A 2-year-old girl presents with abdominal pain and a fever of 38.5°C. She had diarrhea and the "stomach flu" 4 days ago. Over the past 2 days the mother reports that her child has had vomiting and episodes of severe abdominal pain in which she draws up her legs onto her abdomen. Between episodes the patient is listless and lethargic. She has had several bowel movements containing blood mixed with mucus. On examination the abdomen is moderately distended and tender on the right side but with no evidence of peritonitis.
What is the most likely dx? Why is this patient passing blood in her stools? How should this patient be treated?

4) A 9-month-old male who had been born 1 month early has been increasingly irritable over the past 4 hours and is found to have right-sided groin and scrotal swelling. The parents report one episode of nonbilious vomiting. The child is in obvious distress. The abdomen is mildly distended but not tender. There is a firm, tender mass extending from the right groin into the scrotum.
What embryological events account for this patient's condition? What organs or structures are most at risk? How should this patient be treated?

5) A 2-year-old boy is brought to the ED with massive lower GI bleeding. He has not had any abdominal discomfort and has previously been well. On examination he is pale and hypotensive with maroon blood on digital rectal examination.

What is the most important consideration in initially treating this patient? What is the most likely dx? What other complications may also arise from this patient's condition?

6) A 6-week-old infant presents to the ED crying with a report of several episodes of bilious vomiting over the past few hours. He has never had an episode like this before. His abdomen is soft and nondistended but he is in mild distress and crying, with little ability of his parents to console him.

What is the most important consideration in evaluating this patient? What diagnostic study is most crucial?

7) A 2-year-old boy is found by his pediatrician to have a right-sided abdominal mass that is hard, smooth, and fixed. His parents have noticed that he has been irritable for the past 2 weeks with unexplained low-grade fevers. His blood pressure is elevated.

What are the diagnostic possibilities and what is most likely? How should this patient be investigated?

8) A 1-month-old infant is noted to be jaundiced. His parents report that his stools have been white. On examination the liver is palpably enlarged and firm. Serum bilirubin (total/direct) is 16/9 mg/dL, AST is 100 IU/L, ALT is 120 IU/L, and GGT is 200 IU/L.

What are the diagnostic possibilities? What further studies are indicated?

In Memoriam

Philip J. Wolfson, MD, Professor of Surgery, Jefferson Medical College, was an outstanding pediatric surgeon and surgical educator. Just prior to his untimely death during the editing of this volume, he wrote about the "hidden curriculum," the violations of professionalism by attendings and residents that undermine the teaching of best behaviors.[1] Dr. Wolfson pointed out that students often feel trapped and powerless to speak out when they witness unprofessional behavior and suboptimal care. He was an advocate of empowering students to speak out with impunity. For Dr. Wolfson, this was not only a better educational model but also the key to patient safety and better patient care. A "pearl" of a professor himself, Dr. Wolfson's Professor's Pearls for the pediatric surgery section are published posthumously herein.

Reference

1. FOCUS on Surgical Education, publication of the Association for Surgical Education, Summer 2007.

Discussion by Philip J. Wolfson, MD, Professor of Surgery, Jefferson Medical College, Philadelphia, Pennsylvania

Answer 1

This baby has gastroschisis, a congenital condition in which a portion of the viscera protrudes through a defect lateral (usually to the right) of the umbilical cord. Unlike in an omphalocele, there is no covering membrane, and the exposed intestine becomes thickened and edematous, often leading to a delay in function of the GI tract after surgical repair due to chronic inflammation of the exposed bowel. Also, as is the case with this baby, there is often an associated atresia where a segment of intestine ends blindly. These babies are at immediate risk for ischemia of the exteriorized viscera, fluid and heat loss, and infection. The bowel should remain on top of the baby or she should be turned on her side to avoid kinking the vascular supply; the intestine should be kept moist and the abdomen wrapped in sterile plastic; IV fluids, broad-spectrum antibiotics, and NG suction should be administered.

Answer 2

The baby most likely has a congenital diaphragmatic hernia, which must be considered in any newborn infant with respiratory distress and a scaphoid abdomen. A CXR will show loops of intestine in the chest (or opacity in the right chest for the less common right sided hernias if the liver is involved), deviation of the mediastinum, and loss of the diaphragmatic contour. Surgical repair is no longer performed immediately since the respiratory insufficiency is caused mostly by pulmonary hypertension and lung hypoplasia rather than by the mechanical effect of the hernia. The baby therefore needs to be resuscitated and stabilized prior to surgery, which often takes a number of days. Intubation with positive pressure ventilation should be instituted immediately using the lowest settings necessary to avoid severe hypoxia and acidosis. If needed, exogenous surfactant and inhaled nitric oxide may be added. Extracorporeal membrane oxygenation is used if all else fails.

Answer 3

The possibility of an intussusception should be considered in any child from 6 months to 2 or 3 years of age with unexplained abdominal pain. In this patient the classical symptoms of intermittent bouts of pain with irritability and lethargy, along with vomiting and "currant jelly" stools, add to the likelihood of this dx. The blood in the stool is due to mucosal ischemia, which develops from the mesenteric occlusion that can result from the intussusception. IV fluids and antibiotics are administered, and a contrast enema (using barium or air as contrast) must be performed, which will be diagnostic and often therapeutic. Alternatively, ultrasonography may be used as a screening test.

Answer 4

This baby has an indirect inguinal hernia that results from a failure of the processus vaginalis to obliterate. Not only is the intestine at risk for necrosis, but pressure on the spermatic vessels endangers the testicle as well. Manual reduction should be attempted in order to convert an emergency situation into an elective one, and this is usually successful in children—the only contraindications to attempted reduction are clinical peritonitis or changes of the skin overlying the hernia (erythema, discoloration, edema), which would suggest necrosis already developing.

Answer 5

Any patient with massive GI bleeding needs to be immediately resuscitated with IV fluids (usually lactated Ringer's solution) and packed RBCs administered through a large-bore IV catheter. The most common cause of painless, massive lower GI bleeding in the pediatric population is a Meckel's diverticulum with heterotopic gastric mucosa. Other potential complications of a Meckel's diverticulum are inflammation and small intestinal obstruction.

Answer 6

Any patient under 1 year of age who is vomiting bile must be presumed to possibly have midgut volvulus because the consequences are so dire if not recognized and corrected promptly. Early on there may be no other abnormalities on physical examination, and plain radiographs of the abdomen may appear deceptively unremarkable—by the time there is evidence of peritonitis, it may be too late to salvage the small intestine. An upper GI contrast x-ray series is critical to find the location of the ligament of Treitz. If there is evidence of malrotation, the child needs to be operated upon immediately.

Answer 7

This child may have a neuroblastoma, Wilms' tumor, hepatoblastoma, or a hydronephrotic kidney. The systemic symptoms and hypertension as well as the fixed nature of the mass is most suggestive of a neuroblastoma. He should have a CBC and U/A, and serum α-fetoprotein level and urine catecholamine levels should be determined. Although plain abdominal x-rays and ultrasonography may be useful, abdominal CT or MRI will provide the most detailed information about the nature of the mass, including site of origin and extent.

Answer 8

Possible causes of direct hyperbilirubinemia in an infant who has not received parenteral nutrition and does not have an obvious underlying disorder include biliary atresia, neonatal hepatitis, biliary hypoplasia, a choledochal cyst, α_1-antitrypsin deficiency, and exposure to intrauterine viral infections. Workup should include complete liver function tests, TORCH titers, an α_1-antitrypsin level, and abdominal ultrasonography. If no cause is revealed by these studies, a hepatobiliary nuclear scan (with pretreatment with phenobarbital) is indicated. If there is no excretion into the GI tract, biliary atresia must be further investigated with a liver biopsy and operative exploration.

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Chapter 70
Liver Transplant Evaluation (Case 51)

Hilary A. Sanfey MB, BCh

Case: A 45-year-old man with abnormal liver function tests and a history of heavy alcohol use is referred for liver transplant evaluation.

Speaking Intelligently

When asked to evaluate a patient for liver transplantation, I look at the underlying reason for liver failure, the patient's age and medical comorbidities, and the status of his support system in order to determine if the patient is a transplantation candidate. If there are no obvious contraindications to proceeding with the transplantation workup, I obtain the laboratory and radiological tests outlined below. Patients with a hx of substance abuse will also require a full psychiatric assessment to determine suitability and risk for future noncompliance.

PATIENT CARE

Clinical Thinking

In evaluating a patient for liver transplantation it is important to:

- Make a dx of irreversible liver disease. Liver transplantation should be considered in all patients with end-stage liver disease (ESLD) who have failed to respond to medical treatment.
- Assess the severity (sick enough to transplant but not too sick to survive).
- Identify contraindications to transplantation. Absolute contraindications include significant nonhepatic malignancy, active infection, or substance abuse.

History

- Inquire about symptoms of ESLD, including encephalopathy, ascites, GI bleeding, pruritus, altered sleep pattern, tremor.
- A detailed substance abuse hx is important to assess the use of alcohol and recreational drugs.
- Ask about past medical and surgical hx, specifically a hx of malignancy or active infection.

Physical Examination

- Full physical examination.
- Focused GI examination. Note the presence of jaundice, excoriation from pruritus, tremor, ascites, caput medusae, palmar erythema, spider nevi, and hepatosplenomegaly.

Tests for Consideration

Editor's note: In general, preoperative testing for a patient undergoing liver, kidney, or cardiac transplantation has four objectives:

1. **Compatibility testing**
2. **Assessing the patient's current physiology**
3. **Testing the status of the patient's immune system and testing for the possible harboring of occult infection**
4. **Screening for the possibility of underlying, undiagnosed malignancy** (as the transplant patient will require immunosuppression)

1. **Compatibility testing**
   - ABO blood group **$30**
2. **Optimizing current physiology**
   - CBC, metabolic panel, LFTs **$84**
   - Prothrombin time to assess synthetic function **$25**
   - EKG (and cardiac evaluation if needed) **$50 ($500)**
3. **Testing immune status and testing for occult infection**
   - Anergy panel, PPD, HIV test **$115**
   - CXR **$136**
   - Culture urine/sputum/blood to r/o infection **$45**
   - Hepatitis panel (hepatitis B/C) **$65**
4. **Screening for underlying malignancy**
   - Prostate-specific antigen (men > 50 years) to r/o prostate cancer **$65**
   - MRA of the abdomen to look at anatomy of liver and to r/o tumors **$2,500**
   - α-Fetoprotein to screen for hepatocellular tumor **$62**
   - PAP smear/mammography (women > 40 years) to r/o malignancy **$125**

The patient's past medical hx or symptoms may indicate other tests.

Interpretation of Liver Function Tests

↑Bilirubin	↑Alkaline phosphatase	↑AST	↑ALT	↓Albumin	↑INR	↑γGT
↑Suggests hepatocellular disease or cholestasis; ↑unconjugated suggests hemolysis	Suggests cholestasis or infiltration of liver parenchyma	Elevations suggest hepatocellular disease; ALT<AST in alcoholic disease		Albumin and INR reflect liver's synthesis of proteins; ↓albumin and ↑INR reflect severity of ESLD		Parallels ↑ALP; elevated in alcohol use

ESLD, end stage liver disease

Clinical Entities — Medical Knowledge

Common Causes of Chronic Liver Disease

Cirrhosis is the term used to describe liver disease characterized by bridging fibrosis and nodular regeneration due a wide variety of causes. **See Sabiston 28, 53; Becker 18, 67.**

Cause of Cirrhosis	Diagnosis	Incidence (% of patients undergoing transplantation)
Hepatitis C virus (HCV)	Positive serology for HCV	40%
Alcohol	Hx	15%
Primary biliary cirrhosis (PBC)	Positive antimitochondrial antibody Markedly elevated alkaline phosphatase/total bilirubin	4%
Primary sclerosing cholangitis (PSC)	Clinical picture of chronic bile duct injury	5%
Autoimmune hepatitis	More common in women associated with autoantibodies	7%
Hepatitis B virus (HBV)	Positive serology for HBV	5%–10%
Cryptogenic	Dx of exclusion, synonymous with idiopathic	15%

ZEBRA ZONE

a. Nonalcoholic steatohepatitis (NASH): NASH or nonalcoholic fatty liver disease is fatty inflammation of the liver when this is not due to excessive alcohol use. It is a major cause of cryptogenic cirrhosis of the liver. **See Sabiston 53.**

b. Polycystic liver disease: This is an inherited disorder characterized by many cysts of various sizes scattered throughout the liver. Most cases are inherited as an autosomal-dominant genetic trait. Sometimes cysts are found in the liver in association with the presence of autosomal-dominant polycystic kidney disease**. See Sabiston 52, Becker 18.**

Medical Knowledge — Liver Transplant

Surgical Anatomy

- Almost always orthotopic: the transplant liver placed in previous native liver site
- Usually involves 5 separate anastamoses: upper vena cava, lower vena cava, portal vein, hepatic artery, and bile duct
- Donor gallbladder removed

Immunosuppression

Long-term immunosuppression usually is maintained with regimens of immunosuppressive drugs, including Tacrolimus, Cellcept, and prednisone.

Rejection

- **Acute graft rejection** may occur in 40–60% of cases, most often at 7–14 days post-transplant. Acute rejection presents clinically as elevated LFTs and right upper quadrant pain. A rise in bilirubin and alkaline phosphatase and hepatocellular enzymes (ALT and AST) is classic. Symptoms may include fever, liver tenderness, and anorexia. Generally treated with high-dose steroids.
- **Chronic graft rejection,** the major cause of late graft failure, occurs in about 5% of patients, and as in kidney transplant, there is no effective treatment. Dx is made by liver biopsy.

Other Key Issues

- Listing based on MELD formula, which prioritizes patients according to their risk for death if not transplanted
- No cross-match required to assess recipient compatibility with the donor liver
- Donor and recipient size must be comparable

See Sabiston 28, Becker 67.

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title

What have we learned about primary liver transplantation under tacrolimus immunosuppression? Long-term follow-up of the first 1000 patients

Authors

Jain A, Reyes J, Kashyap R, Rohal S, Abu-Elmagd K, Starzl T, Fung J

Reference

Annals of Surgery 1999;230(3):441–448

Problem
Patients take immunosuppression for life following liver transplantation. Therefore, long-term follow-up with regard to safety and efficacy are important.

Intervention
Ten-year prospective follow-up of 1,000 patients at a single institution who underwent liver transplantation and were treated with tacrolimus

Quality of evidence
The data are compared with historical controls from the cyclosporine era.

Outcome/effect
The actual 6-year overall patient survival rate was 68.1%, with significant differences in the patterns of survival among the different age groups. The first year after liver transplantation, infection, recurrence of disease, de novo malignancies, and cardiovascular events were the main causes of graft loss and death. The rates of acute rejection beyond 2 years were approximately 3% per year. Malignancy occurred in 82 patients, including 41 patients with lymphoproliferative disorders. Pediatric patients have a better long-term outcome than adults.

Historical significance
This is the largest series in the literature that evaluates the long-term efficacy and side effects of tacrolimus. This article provides a model for best patient care in the postcyclosporine era.

Interpersonal and Communication Skills

Obtaining Consent in the Transplant Patient
As many patients referred for liver transplantation are encephalopathic, it is advisable to have a family member present when obtaining consent. The discussion should include a clear explanation of each of the multiple-risk categories and an opportunity for the patient and family members to ask questions. Risk categories discussed should include anesthetic risks, surgical risks, risks specific to the transplantation procedure, risks related to immunosuppression, and possible alternatives to transplantation.

Professionalism

Principle of Social Justice

Patients on the transplant waiting list are prioritized by disease severity. One patient can never be considered more "deserving" than another based on etiology, age, gender, race, or ethnicity. For many patients liver failure is the result of heavy alcohol use leading to alcoholic cirrhosis or IV drug use leading to infection with HCV. All such patients will complete a period of rehabilitation prior to their transplantation. One should avoid making value judgments based on the etiology of the patient's liver failure.

Systems-Based Practice

National Operations: The UNOS System

Origins and Overview

The United Network for Organ Sharing (UNOS) is a government-run organization that coordinates and manages the allocation of solid human organs.

Liver Transplants

In 2002, UNOS adopted the Model for End Stage Liver Disease (MELD) as the disease severity index by which organ allocation priorities for liver transplantation should be determined. (www.unos.org/resources/meldPeldCalculator.asp). The current policy retains an emergency status (status 1) for patients with acute liver failure or for those with primary graft failure within 1 week of transplantation. All non–status 1 candidates are prioritized by their MELD score. Organs are first offered to local recipients within the donor organ procurement organization. If no patient accepts the liver, organs are then offered outside this local geographical area to the region and finally nationally. MELD is based on three laboratory variables: bilirubin, creatinine, and INR.

Kidney Transplants

In 1984, UNOS established a point system for allocation of deceased donor kidneys designed to balance fairness (waiting time) with medical benefit (HLA matching) for recipients of kidneys of deceased donors. This system has been changed several times to adjust for racial and biological differences, and to deal with the increasing disparity between the number of patients on the waiting list and the number of deceased donors.

Heart Transplants

In 1999, UNOS prioritized organ allocation for cardiac transplantation based on recipient priority status, geographic distance between donor and potential recipient, and duration on the waiting list.

Chapter 71
Kidney Transplant Evaluation (Case 52)

Nicole D. Figueredo MD, James Lim MD, and Francisco Badosa MD

Case: A 46-year-old female on dialysis for 3 years with end-stage renal disease due to glomerulonephritis is referred for kidney transplant evaluation.

Speaking Intelligently

When I evaluate a patient with end-stage renal disease (ESRD) for kidney transplantation, I want to be sure the patient "sees the big picture." By the time patients are evaluated for transplantation, most have an awareness of their problem and most have had dialysis experience. Nonetheless, I ascertain that each patient has a complete understanding of ESRD, its tx alternatives, and the realities of transplantation. Accordingly, I carefully review with them hemodialysis, peritoneal dialysis, and the possibilities of living related, unrelated, and cadaveric kidney transplants.

PATIENT CARE

Clinical Thinking

All patients with ESRD who require or are expected to require dialysis and who have a creatinine clearance of 20 mL/min or less should be referred for a kidney transplantation evaluation. To be considered for kidney transplantation, a patient must be:

- Free of absolute contraindications (see below).
- Medically fit and able to tolerate surgery and anesthesia.
- Psychosocially stable and compliant.
- Capable of understanding the risks and benefits of kidney transplantation versus dialysis.

Absolute contraindications to kidney transplantation include:

- Active infection that cannot be eliminated by medical or surgical means (i.e., HIV, hepatitis B, active tuberculosis [TB]).
- Severe advanced cardiopulmonary disease (making the patient a poor surgical candidate).
- Adverse psychosocial conditions (i.e., substance abuse or medical noncompliance).
- Recent hx of malignancy.

History

- The physician should inquire about the cause of the patient's native renal disease: does the patient have a hx of diabetes, hypertension, recurrent UTIs/pyelonephritis, polycystic kidney disease, glomerulonephritis, or autoimmune or familial diseases?
- Investigate potential causes of HLA sensitization: hx of prior transplantation, number of pregnancies, and blood transfusions.
- Ask about comorbid conditions, specifically a hx of infectious disease (cytomegalovirus [CMV], hepatitis B/C, HIV, UTIs, TB), malignancy, cardiac, pulmonary, hematologic, or psychiatric illnesses.
- Obtain a thorough past surgical hx, including vascular or urologic surgeries, and any bleeding, clotting, or anesthesia-related complications.
- Inquire about the patient's family hx to evaluate potential living donors.
- It is also important to know the patient's dialysis hx, medications, and allergies.

Physical Examination

- A full physical examination should be performed.
- It is important to r/o any potential sources of infection by examining the sinuses, teeth, and catheter sites.
- Pay special attention to the lower extremity examination to r/o peripheral vascular disease as the transplanted kidney will be implanted into the iliac vessels.

Tests for Consideration

Editor's note: Preoperative testing for kidney transplantation has four objectives:

1. **Compatibility testing**
   - ABO blood group, HLA-A, -B, -DR, panel-reactive antibody, lymphocytotoxic crossmatches **$240**
2. **Optimizing current physiology**
   - CBC, metabolic panel, LFTs **$21**
   - EKG (and cardiac evaluation if needed) **$50 ($500)**
   - Dental examination (within past year) **$50**
   - Voiding cystourethrography if GU symptoms present **$250**
   - Ultrasonography of the kidney **$185**
3. **Testing immune status and testing for occult infection**
   - Anergy panel, PPD, HIV test **$115**
   - CXR **$136**
   - Culture urine/sputum/blood to r/o infection **$45**
   - Hepatitis panel (hepatitis B/C) **$65**
   - HBsAg, HBsAb, and HBcAb; hepatitis C antibody; and RNA assay by PCR **$65**
   - CMV (IgG, IgM titer) **$45**

4. **Screening for underlying malignancy**
   - Prostate-specific antigen (men > 50 years) to r/o prostate cancer **$65**
   - PAP smear/mammography (women > 40 years) to r/o malignancy **$125**
   - Colonoscopy (men/women > 50 years) **$625**

Clinical Entities — Medical Knowledge

Common Causes of End-Stage Renal Disease

Chronic renal failure is a slowly progressive loss of renal function over a period of months or years. Severe kidney dysfunction is reached when kidney function is reduced to 10% or less of normal function. **See Sabiston 28, Becker 67.**

Cause of ESRD in the United States	Incidence (% of patients with ESRD on dialysis)
Diabetic nephropathy	40
Hypertension	28
Glomerulonephritis	12
Cystic kidney disease	3
Other	18

Clinical Options

The transplantation evaluation is not only meant to assess the patient's candidacy to be a recipient, but should also allow the patient to explore all options and decide what would best suit his or her lifestyle and well-being. For many older or single patients, dialysis may provide them with social interaction, while for others it is a significant inconvenience. Patients should be informed that, if they choose transplantation, there are different types of donors and different wait times to transplantation. The pros and cons of all options available should be explained to the patient. Options include:

- Hemodialysis
- Peritoneal dialysis
- Living related/unrelated transplant
- Deceased donor transplant
- Expanded criteria donor transplant

See Sabiston 28, Becker 67.

Kidney Transplantation in Diabetics

Type I diabetics with ESRD should be considered for either simultaneous pancreas and kidney (SPK) or pancreas after kidney (PAK) transplantation. SPK has the advantage of a single operative procedure and easier management of rejection because both organs are from the same donor. On the other hand, with the shortage of organs and increased waiting time, if a living kidney donor is available, it may be beneficial to proceed with a living donor (LD) kidney transplant and then a PAK transplant when a deceased donor (DD) pancreas becomes available.

In the past, PAK 1- and 3-year graft survival rates were significantly worse than those for SPK, but in recent years the results have greatly improved, making LD kidney and PAK an excellent alternative to SPK. **See Sabiston 28, Becker 67.**

Medical Knowledge — Kidney Transplant

Surgical Anatomy

- Almost always retroperitoneal placement of transplant kidney
- Renal artery to external iliac artery; renal vein to external iliac vein
- Intraperitoneal placement if recipient less than 20 kg
- Native kidneys left in place with rare exceptions

Immunosuppression

Immmunosuppression generally consists of a calcineurin inhibitor such as FK506 (Prograf or tacrolimus), CellCept (mycophenolate), +/– oral steroids (prednisone).

Other Drugs to Know

- **Cyclosporine:** calcineurin inhibitor
- **Daclizumab, basiliximab:** anti-interleukin 2 receptor antibodies, typically used in times of rejection
- **RATG:** polyclonal antibody against T-cells
- **OKT3:** monoclonal against T-cells
- **Sirolimus:** key regulatory kinase inhibitor

Rejection

- **Hyper-acute rejection:** Damage caused is irreversible damage due to preformed circulating antibodies occurring within minutes to hours of release of clamps of the circulatory system. Rare if the cross-match is negative.
- **Accelerated acute rejection:** Occurs within 24 hours to 4 days after transplant due to the prior sensitization of the recipient to the donor antigens as the result of transfusions, prior transplants, or pregnancy.

- **Acute rejection:** Occurs days to weeks after transplant. Approximately 90% are cellular-mediated and easier to treat. 5–10% of these cases are due to humoral-mediated.
- **Chronic rejection:** Occurs over months to years with progressive graft loss associated with the diminished renal functioning. Probably multifactorial.

Other Key Issues

- Listing based on GFR (glomerular filtration rate) less than 20 mL/min
- Living donor recipients do better than cadaver donor recipients . . . better graft/patient/long-term survival
- Patients live longer and have an improved quality of life after transplant vs. staying on dialysis

See Sabiston 28, Becker 67.

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title

Strategies to improve long-term outcomes after renal transplant

Authors

Pascual M, Theruvath T, Kawai T, Tolkoff-Rubin N, Cosimi AB

Reference

New England Journal of Medicine 2002;346(8):580–590

Problem

Although long-term allograft survival has improved, chronic rejection and death with a functioning graft remain the leading causes of the late loss of renal allografts, resulting in an annual rate of loss of 3% to 5%. Thus, the definition of strategies that may improve long-term outcomes has become a priority in renal transplantation

Intervention

Extensive review of factors implicated in late allograft failure and the strategies to improve long-term survival and life expectancy

Quality of evidence

Review article and historical perspective

Historical significance/comments

This article provides a critical analysis of the causes of late allograft loss and reviews the future strategies being developed with the ultimate goal of inducing tolerance.

Interpersonal and Communication Skills

Reporting Co-worker Behaviors

A major cause of serious medical error is related to the failure of co-workers to report the risky, dangerous, and/or inappropriate behavior of a colleague. Silence can be deadly. A recent study determined that more than half the health-care workers surveyed had observed a co-worker performing incompetently, breaking rules, making mistakes, or cutting corners. The same study found that most of those observing these improprieties failed to discuss the incident with the guilty party or report the matter to a person in authority. Health-care providers must be mindful that their first loyalty is to their profession. Silence regarding the irresponsible behavior of a colleague could translate to catastrophic consequences for patients.

Professionalism

Principle of Social Justice; Commitment to Improving Access to Care

Patients are placed on the transplant list after they have been referred for a transplantation evaluation and deemed a potential candidate. No preference is made on the basis of age, sex, ethnicity, or severity of disease. Similarly, patients are not denied transplantation unless they have certain contraindications or are considered poor candidates for the surgery.

Society and our profession should discourage *paid* donation. Organ donation in exchange for financial or social gain is prohibited in the United States but continues to occur in many parts of the world and often leads to criminal acts. It is important to ascertain that living related and unrelated donations are truly altruistic; accordingly, both the recipient and the donor must undergo psychiatric evaluations prior to transplantation.

Systems-Based Practice

Reimbursement: Medicare

Patients undergoing kidney transplantation are typically on dialysis before transplantation. As ESRD patients, they are entitled to Medicare. Medicare is the federal insurance program designed to care for the elderly and disabled. Enacted in 1965 as part of President Johnson's Great Society, Medicare was developed for the elderly and disabled who did not have employer-sponsored coverage. The program, which is administered by the Centers for Medicare and Medicaid Services (CMS), consists of four parts, and in 2006 the program cost $400 billion.

Medicare Part A covers hospitalizations and is centered on the system of diagnosis-related groups (DRGs). Developed in 1983, DRGs represent the original "case rate" method of payment. A DRG is a code that represents the dx of a patient; the hospital gets paid a certain amount for each admission depending on a patient's DRG.

Medicare Part B pays for physician office visits, outpatient care, and durable medical equipment. Physicians are paid based on current procedure technology (CPT) codes; among these codes is a subset of evaluation and management (E&M) codes that provides for five different levels of patient visits.

Medicare Part C, also known as Medicare Advantage, and formerly known as "Medicare + Choice," was developed as part of the Balanced Budget Act of 1997. It allows Medicare recipients to choose to have their Medicare coverage provided by a private payer. These plans are typically HMO-type plans that are able to save money by limiting their coverage to networks of providers. Savings are then used to offer greater coverage of preventive care and drug benefits. To qualify for Part C, one must be enrolled in both Medicare Parts A and B.

Medicare Part D, enacted through legislation in 2003, is the prescription drug benefit component of Medicare. Until then, Medicare did not provide for prescription drugs given outside the hospital or physician's office. Similar to Medicare Part C, Part D is being administered by private insurance plans that are reimbursed by CMS. Medicare recipients must elect to participate in Part D unless they are dual-eligible (meaning eligible for Medicare and Medicaid), in which case they are automatically enrolled. There has been significant controversy over Medicare Part D because the legislation prevents the government from negotiating discounts on drugs that might otherwise be available to entities that make mass purchases. In addition, the program's coverage leaves a substantial gap: there is coverage for the first $2,250 of drugs, as well as costs above $5,100, but from $2,251 to $5,099 there is a so-called "doughnut hole" in the coverage.

Chapter 72
Cardiac Transplant Evaluation (Case 53)

Jaromir Kohout MD *and Louis Samuels* MD

Case: A 55-year-old man with severe coronary artery disease and hx of heavy smoking presented with an acute myocardial infarction not amenable to percutaneous revascularization. After being taken to the operating room for surgical revascularization, he developed profound cardiogenic shock unresponsive to medical therapy. A ventricular assist device (VAD) was placed. He remained in the ICU, awaiting heart transplantation.

Speaking Intelligently

When asked to evaluate a patient for heart transplantation, I examine the underlying reasons for the patient's heart failure, his age, comorbidities, and risk factors. I review the patient's echocardiogram, coronary angiogram, as well as all of his current vasoactive medication and type of mechanical circulatory support. I consider the possible options of advanced medical, interventional, or nontransplant surgical therapies.

PATIENT CARE

Clinical Thinking

In evaluating a patient for heart transplantation it is important to:

- Assess the severity of heart failure. The prioritization of appropriate recipients for transplantation is based on survival and quality of life expected to be gained.
- Identify the most important contraindications for heart transplantation, such as fixed pulmonary hypertension, neoplasm, HIV, or the noncompliant or psychosocially unsuitable candidate.

History

- Candidates for cardiac transplantation generally present with New York Heart Association (NYHA) class III symptoms (patients with marked limitation of activity comfortable only at rest) or class IV symptoms (patients confined to bed or chair; any physical activity brings on discomfort and symptoms occur at rest).

- In 2001, a new class system for heart failure patients was released by the American College of Cardiology and American Heart Association. It is meant to be used along with the NYHA functional class system and classifies heart failure in “stages” A through D.
- Stage C patients experience congestive heart failure (CHF) symptoms and have underlying structural heart disease.
- Stage D patients suffer from end-stage CHF, requiring frequent hospitalizations or special treatments such as a left ventricular assist device, artificial heart, inotropic infusions, heart transplantation, or hospice care.

Physical Examination

- A detailed physical examination should be performed with emphasis on signs and symptoms of heart failure. Signs of decompensated left heart failure include displaced apical beat (usually to the left due to cardiomegaly), pathologic S3 gallop, S4, and crackles at the lung bases due to pulmonary edema. Increased intensity of the pulmonic component of S2 is also indicative of left heart decompensation. The most common symptom of left heart failure is shortness of breath.
- Signs of right heart failure include peripheral edema, nocturia (due to increased venous return with leg elevation), jugular venous distention, hepatomegaly, hepatojugular reflux, and right ventricular heave. The most common symptoms of right heart failure are bloating and fatigue.
- In most patients, one often finds a combination of signs and symptoms due to right- and left-sided dysfunction.

Tests for Consideration

1. **Compatibility testing**
   - Blood type, antibody screen, CBC, CMP Panel-reactive antibody HLA typing and crossmatch (completed when donor identified). **$240**
2. **Optimizing current physiology**
   - CBC to look for anemia, thrombocytopenia **$21**
   - Comprehensive metabolic panel **$30**
   - CXR and pulmonary function tests **$190**
   - EKG to look for cardiac disease; echocardiography, right and left heart catheterization, coronary angiography **$2,500**
   - B-natriuretic peptide (BNP) **$50**
   - U/A and creatinine clearance **$85**
3. **Testing immune status and testing for occult infection**
   - Anergy panel, PPD, HIV test **$115**
   - Culture urine/sputum/blood to r/o infection **$45**
   - Hepatitis panel (hepatitis B/C) **$65**
   - HBsAg, HBsAb, HBcAb; hepatitis C antibody; and RNA assay by PCR **$65**
   - Cytomegalovirus (IgG, IgM titer) **$45**

4. **Screening for underlying malignancy**
   - Prostate-specific antigen (men > 50 years) to r/o prostate cancer **$65**
   - PAP smear/mammography (women > 40 years) to r/o malignancy **$125**
   - Colonoscopy (men/women > 50 years) **$625**

Interpretation of Laboratory Tests

B-natriuretic peptide (BNP) assays are key in evaluating heart failure patients. BNP levels greater than 100 pg/mL identify patients with heart failure with over 95% specificity and over 98% sensitivity.

Peak ventilatory oxygen uptake (Peak Vo_2): This parameter provides the most objective assessment of functional capacity in patients with heart failure and is an important predictor of when to perform cardiac transplantation. It is measured during exercise with rapidly responding gas analyzers that are capable of breath-by-breath determination of O_2 and CO_2 concentrations. Patients with peak Vo_2 14 mL/kg per minute are likely to experience the most pronounced improvement in survival with transplantation.

Clinical Entities — Medical Knowledge

The disease processes that require cardiac transplantation can be divided into three broad categories:

1. **Ischemic cardiomyopathy** (50% of patients): Coronary heart failure not (or no longer) amenable to percutaneous or surgical revascularization, ineffective maximal tolerated medical therapy.
2. **Idiopathic cardiomyopathy** (45% of patients): Idiopathic cardiomyopathy includes patients in whom the coronary arteries are widely patent and not the cause of the dilated heart. Its etiology is unknown, and current research suggests a primary or reactive pathology of the myocyte.
3. **Other causes** (10% of patients): This category includes patients with hypertrophic, diabetic, valvular cardiomyopathy, viral myocarditis, toxic cardiomyopathy (chemotherapy), or infiltrative cardiomyopathy (associated with sarcoidosis or amyloidosis).

See Sabiston 60.

Medical Knowledge — Heart Transplant

Surgical Anatomy

- Donor superior vena cava is ligated.
- Recipient heart removed by dividing pulmonary artery and aorta distal to the valves.
- If donor heart has patent fossa ovalis, it is closed.
- Almost always orthotopic.
- Biatrial technique developed by Dr. Shumway is standard and incorporates four anastamoses: left and right atria, pulmonary artery, and ascending aorta.
- Bicaval technique involves six anastamoses: bilateral pulmonary veins, upper and lower cava, ascending aorta, left and right atria.

Immunosuppression

Long-term immunosuppression is usually maintained with regimens of:

1. Calcineurin inhibitor (e.g., cyclosporine A or FK506)
2. Purine analog (e.g., azathioprine or mycophenolate)
3. Steroid (e.g., prednisone)

Drugs to Know:

- **Cyclosporine A:** Introduced in 1982, this drug dramatically improved transplant outcomes. Derived from Norwegian soil samples containing the fungus *Tolypocladium inflatum* Gams, it works by preferentially suppressing activation of T lymphocytes by inhibiting production of the lymphokine interleukin-2. Side-effects include fine tremor of the hand, hirsutism, gingival hyperplasia, increased appetite, and hyperlipidemia. Its main problematic side effect is constriction of preglomerular arterioles, which causes hypertension.
- **FK506:** Also sold as Prograf (tacrolimus), this drug was discovered in 1984 from the fermentation broth of a Japanese soil sample that contained the bacteria *Streptomyces tsukubaensis*. Its immunosuppressive activity is similar to cyclosporine A, but it has fewer side effects; it can cause tremors (but has less nephrotoxicity and does not result in hirsutism), gingival hyperplasia, hyperlipidemia, or increased appetite.
- **Azathioprine (Imuran):** A less toxic modification of mercaptopurine. Mercaptopurine was used to treat myelocytic leukemia and also was observed to prolong skin graft survival in rabbit models in 1959; it was introduced into clinical transplantion in 1962. Azathioprine, an inhibitor of cell division and nucleotide metabolism, was popular from 1969 to 1996, when mycophenolate became available.
- **Mycophenolate:** Also known as CellCept, this drug acts like azathioprine, but primarily affects lymphocytes and largely spares

most other rapidly dividing cell populations such as bone marrow and gut epithelium. It inhibits the enzyme inosine monophosphate dehydrogenase, which is crucial to de novo synthesis of guanosine monophosphate.
- **Prednisone:** Introduced early in transplantation, steroids play a global role by (a) causing the emigration of circulating T cells from intravascular tissue compartments to lymphoid tissue and (b) inhibiting the production of T cell lymphokines that are needed to amplify macrophage and lymphocyte response. A tapering of steroids is common, and steroid-free immunosuppression is becoming popular to avoid the many adverse effects of chronic steroids.

Rejection
- Acute rejection is T-cell mediated and can present with subtle, nonspecific signs and symptoms that can easily be missed.
- Acute rejection is most common in the early months and within the first year after transplantation. Endothelial biopsy establishes the dx.

Other Key Issues
- Donor recipient size matching important, with height taking priority over weight
- Hypothermia key to excellent preservation during implantation
- Failure of the right ventricle in the perioperative period accounts for almost half of all complications

See Sabiston 28, Becker 67.

Practice-Based Learning and Improvement: Evidence-Based Surgery

Title
Taking heart—cardiac transplantation past, present, and future

Author
Hunt SA

Reference
New England Journal of Medicine 2006;355(3):231–235

Problem
Initial enthusiasm for heart transplants was curbed when it became evident that survival rates were usually measured in days or weeks.

Intervention
Decades of intensive research, more effective immunosuppressive agents, advances in critical care, and development of new methods for graft preservation have led to improved results for cardiac transplantation, so there is now an 87% probability that a patient will survive the first year after transplantation.

Quality of evidence
Review article and historical perspective

Historical significance/comments
Excellent and interesting historical review of heart transplantation

Professionalism

Commitments to Honesty with Patients and Patient Confidentiality
Truthfulness and the maintenance of confidentiality are universal principles of professionalism that are often tested in the doctor-patient interaction with the transplant patient.

Be truthful. Cardiac transplant patients are usually well educated about their disease options and prognosis and may ask difficult questions. You are not expected to be able to answer all of the questions patients may have. No matter what your level is in the medical hierarchy, when you do not know the answer to a question it is always best to tell the patient that you will ask for help and obtain the answer.

Always maintain confidentiality when taking care of heart transplant patients. Confidentiality applies not only to the privacy of your patient (the recipient), but also to the privacy of the donor. The donor information that the transplant surgeon may discuss with the recipient is very limited. The recipient should not be provided with details of the donor's death, gender, age, or geographic location.

Interpersonal and Communication Skills

Written Communications Can Often Be Helpful
Patients who are being considered for cardiac transplantation should receive written material explaining the procedure. Written and oral communications reinforce one another and offer patients multiple ways to process information.

Brochures are usually available to explain most standard surgical procedures. We recommend that physicians distribute such materials for patient consideration prior to informed consent discussion and surgery.

In the postoperative period we encourage all patients to prepare a list of questions before their office visits. This allows us to have an agenda for the visit and to involve the patient by asking questions, listening, and responding.

Systems-Based Practice

Reducing Medical Errors

Medical errors are the eighth leading cause of death in this country and account for as many as 44,000 deaths per year (Institute of Medicine report). The total cost of preventable adverse events is estimated at $17 to $29 billion per year. Even the best programs and the best health-care teams are not immune to the ravages of human and system error. However, the dynamics surrounding admission of error pose a challenge to error reduction efforts.

In a survey of health-care professionals, the reasons cited for not reporting medical errors included liability concerns and fear of loss of reputation, job, accreditation, and market share.[1] The failure of physicians to accurately address systems and human factors in adverse events increases the likelihood such that events will recur. Be responsible and respectful in your communication about errors. Utilize approaches that avoid blame and encourage individual honesty, system integrity, and process improvement.

Reference

1. Weissman JS, Annas CL, Epstein AM, et al.: Views from hospital leaders. JAMA 2005;293:1359–1366.

If you have had the opportunity to evaluate a patient considering or undergoing transplantation, you are encouraged to review your patient's course in the context of the Competency Self-Assessment Form on page 35, which can also be found as a Word document on the book's Web site at www.studentconsult.com. Did the organ allocation system work well for your patient?

Professor's Pearls: Transplantation

Section Review

Consider the following clinical problems and questions posed. Then refer to the professors' discussion of these issues.

1) An 18-year-old girl is admitted to the hospital with acute liver failure after deliberately ingesting a bottle of Tylenol. She had admitted to being upset following an argument with her boyfriend. On admission she has grade II encephalopathy (drowsy but arousable) and elevated transaminases, is acidotic, and her INR = 4.5. The attending on call requests that she be evaluated for liver transplantation.

What are the important points to consider in this case?

2) A 31-year-old woman developed congestive heart failure immediately following delivery of a healthy boy. The course of her pregnancy was unremarkable except for excessive vomiting during the first trimester. On the same day of her delivery, she developed severe hypotension and respiratory distress requiring mechanical ventilation. Her echocardiogram showed left ventricular dysfunction with an ejection fraction of 15%.

What is the differential diagnosis of the patient's heart failure? What is the natural history of peripartum cardiomyopathy and how do we diagnose it? If the patient's failure worsens and she cannot be sustained with medical treatment, is she a candidate for heart transplantation?

Discussion by Hilary A. Sanfey, MB, BCh, Professor of Surgery, University of Virginia, and Louis Samuels, MD, Chief of Cardiac Transplantation, Lankenau Hospital, Wynnewood, Pennsylvania

Answer 1

Need for liver transplantation: A patient who is acidotic on admission, encephalopathic, and has a prolonged PT has a 95% chance of dying without a transplant.

Attempted suicide: Some would argue that a patient who has attempted suicide should not receive a scarce resource (donor liver). This patient should have a psychiatric consult in addition to the standard history, physical, and laboratory workup. Unless the patient has a past history of previous drug overdose, depression, or significant psychiatric history, this should be regarded as an impulsive gesture and the patient listed for transplantation.

Follow-up: After transplantation the patient should receive psychiatric counseling and support for at least a year.

Answer 2

Peripartum cardiomyopathy: The timing of this patient's course is classical for peripartum cardiomyopathy, a dilated cardiomyopathy of uncertain etiology that is defined as a development of cardiac failure in the last month of pregnancy or within 5 months after delivery. The prevalence in the United States is estimated to be 1 case per 1,300 to 15,000 live births. It is more common in multiparous women and has been reported more often in twin gestations and in women with preeclampsia. Treatment depends on the severity of patient's heart failure. In general, pregnant women will benefit from diuretics, nitrates, and digoxin. Angiotensin-converting enzyme inhibitors or angiotensin receptor blockers are administered in the postpartum period.

This patient returned 1 month postpartum with deteriorating cardiac function. She underwent implantation of a left ventricular assist device (LVAD) as a bridge to cardiac transplantation. (A ventricular assist device is a mechanical pump implanted into the chest cavity to assist the heart to circulate blood. These devices were originally intended as a bridge to transplantation to support failing hearts until donor hearts became available. Some devices are now used for long-term therapy in patients who are not candidates for heart transplantation. They can support one or both ventricles.)

The patient underwent successful cardiac transplantation 1 month after placement of the LVAD. After recovery, such a patient should receive counseling to avoid further pregnancies and should consider permanent birth control measures.

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Chapter 73
Introduction to Surgical Critical Care

Thomas A. Santora MD

The ICU is an intimidating place, especially for the uninitiated. Patients in the ICU have potentially life-threatening multisystem illnesses, and the most advanced technology is utilized for their treatment. Preparation for patient care in the ICU requires review of basic physiology and pathophysiology, familiarization with the equipment used and the information documentation practices, as well as development of a clear systems approach to problem solving. In the systems approach each patient's disease is considered a summation of separate organ systems dysfunction. This helps simplify this complex environment, which at times can seem chaotic and overwhelming. The "art" that is practiced in the ICU involves integration of the effects of separate organ system dysfunction for the purpose of treating the patient as a whole with overall therapeutic effectiveness.

Every ICU uses a flow-sheet to document the physiologic changes that occur over time and in relationship to interventions. Every institution's flow-sheet will appear slightly different. These flow-sheets are usually set up in a systems approach to organize the information. A key to early success in the ICU is knowing how to read and interpret the flow-sheet. Figure 73-1 has been created as an example of flow-sheet data. As an exercise, we have provided a basic recitation of the data by a novice medical student, comparing it to a resident physician's more sophisticated interpretation. The latter is the model to which you should aspire. You are invited to use these examples to learn how to read, interpret, and synthesize the important information on this ICU documentation tool.

Patient summary: 23-year-old; GSW to ABD, S/P bowel resection, colostomy and repair of L common iliac artery
Comorbidities: IV-drug abuse
Weight: 90 kg

POD #3
IV Fluids/Drips:
D5/1/2 NS + 20 KCl @ 175 mL/hr

Medications:
MSO4, Ativan
Antibiotics:
cefazolin, metronidazole

Time	Temp	HR	BP	R	Tube feeds	IV totals	Urine output	NG	BM	pH	pO_2 pCO_2 HCO_3	HB/Crit	WBC	Lytes Na K Cl HCO_3	Glu	Bun Cr	PT PTT INR
	VS				**Input**		**Output**			**ABG**							
4am	98.9	124	132/76	18	40	175	50	600	0	7.56	132 32 30	8.8/25	16.3	134 2.9 100 29	98	28 0.9	
10am	100.0	126	128/74	20	0	175	45	800	0								

PA Catheter

PA	PAO_2	CO	CI

Vent Settings

Mode	R	V_t	PEEP	FiO_2
A/C	10	700	5	.4

Figure 73-1 Example flow-sheet from ICU at Competency General Hospital

Student

- 23-year-old man on POD #3 from abdominal exploration for gunshot wound with injury to the left common iliac artery, small bowel, and colon.
- T_{max} is 100.0, VS are normal except he is tachycardic; his urine output has been 40 to 50 mL/hr. There has been a large NG tube output.
- Physical examination reveals diminished breath sounds at the bases, and the wound dressing is dry; the ostomy is without output.
- Labs show low K^+, an alkalotic pH, and high BUN.
- Due to the large NG tube output, his tube feedings have been held. He is to receive K supplementation.

Chief Resident

- 23-year-old man on POD #3 status-post celiotomy for gunshot wound. Injuries included a tangential wound of the left common iliac artery that required patch angioplasty for repair, 1 foot resection of mid-ileum for clustered small bowel injuries, and a long Hartman's procedure for extensive injury to the descending colon. A feeding jejunostomy was placed. Estimated blood loss was 2,500 mL, for which he received 2 units of packed RBCs. The subcutaneous wound has been managed with wet-dry dressing changes; he remains on antibiotics.
- He is afebrile; he remains tachycardic; urine output is marginal. Physical examination shows dry mucous membranes, warm extremities, clear breath sounds, moderate abdominal distention, no bowel sounds, mild abdominal tenderness, and a viable colostomy in the LUQ without output.
- This patient has developed a contraction alkalosis that is due in part to large NG tube losses. The large NG tube output could be related to reflux of the tube feeding, especially if ileus is developing, or may be related to partial obstruction due to edema at the small bowel anastomosis. Accordingly, tube feedings have been discontinued.
- We will give a bolus of NS (20 mL/kg) to replete intravascular volume. We will continue to hold the feeds for now, begin replacement of the NG tube output, and replete the K to minimize cardiac irritability. To facilitate correction of the pH, the ventilator will be changed to intermittent mandatory ventilation (IMV) mode to reduce minute ventilation and CO_2 elimination.

Chapter 74
Fluid and Electrolyte Disorders

Jennifer L. Denne MD

Cases Considered

1. Sodium 149 mEq/L in 24-year-old male with diarrhea
2. Sodium 154 mEq/L in 24-year-old male with head trauma
3. Sodium 129 mEq/L in 60-year-old female with lung mass
4. Sodium 130 mEq/L in 75-year-old male with congestive heart failure
5. Potassium 2.8 mEq/L in 32-year-old male status-post laparotomy
6. Potassium 6.0 mEq/L in 45-year-old male who was unconscious for 40 hours
7. Calcium 6.0 mg/dL in 34-year-old female status-post total thyroidectomy
8. Phosphorus 6.1 mg/dL in 52-year-old male with renal failure

Speaking Intelligently

When I'm asked to evaluate a patient with an "electrolyte abnormality," I first try to assess the state of the patient's extracellular volume. Once I know if the patient is hypovolemic, euvolemic, or hypervolemic, I can more easily determine the cause of the abnormality as well as the best tx.

Clinical Thinking

When encountering the patient with a fluid or electrolyte abnormality consider the following:

1. What is the volume status of the patient (hypervolemic, euvolemic, or hypovolemic)?
2. Does this patient have an abnormality that is life threatening?
3. Is there another disorder causing this abnormality?
4. What are my tx options and which will be most effective in this patient?

Case 1

A 24-year-old male develops profuse diarrhea 3 days after an appendectomy for acute appendicitis. He has been on IV ampicillin/sulbactam for the past 3 days. On his morning labs, you note that his serum sodium concentration is 149 mEq/L.

Working Dx:
The patient most likely has antibiotic-associated diarrhea or *Clostridium difficile*–associated diarrhea. The concentration of sodium in diarrhea is 40 mEq/L; therefore, he is losing hypotonic fluid through his GI tract. He has hypovolemic hypernatremia.

Medical Knowledge

The normal plasma sodium concentration is 138 to 145 mEq/L. Therefore, hypernatremia is defined as a serum sodium level greater than 145 mEq/L.

A careful hx and physical examination must be performed to clinically assess a patient's extracellular volume status. An acute increase in the patient's weight and/or the presence of peripheral edema (swelling) may indicate an increased extracellular volume. Measurable parameters such as heart rate, blood pressure, and urine output can also be assessed. A patient who has an increased heart rate, decreased blood pressure, and decreased urine output without any signs of heart failure or peripheral edema usually has a decreased extracellular volume.

Key Points: One of the most significant consequences of hypovolemic hypernatremia is poor perfusion of vital organs, leading to a shock state, and cellular dehydration. This can lead to changes in mental status, seizures, and focal neurological deficits.

The most important thing to do for a patient with hypovolemic hypernatremia is to restore the extracellular volume in order to keep the vital organs perfused. Isotonic fluids such as normal saline solution or lactated Ringer's should be used. When the hypovolemia has been corrected, we must calculate and replace the free water deficit.

Total body water (TBW) usually accounts for 60% of the lean body weight in men and 50% of lean body weight in women. However, when hypovolemic hypernatremia is present, the normal TBW is 10% less than usual. Therefore, the normal total body weight in a patient with hypovolemic hypernatremia is 50% of body weight (in kg) in males and 40% of body weight (in kg) in females. The free water deficit is calculated as the difference between the normal TBW and the current TBW, where current TBW = normal TBW $\times 3$ (140/current P_{NA}).

Euvolemia

Males: Normal TBW (L) = $0.6 \times$ weight (kg)
Females: Normal TBW (L) = $0.55 \times$ weight (kg)

Case 2

A 24-year-old male is brought into the ED by fire rescue after sustaining blunt trauma to the head in a motor vehicle collision. He is hemodynamically stable, and CT of the head shows a subdural hematoma without midline shift or mass effect. He is admitted to the ICU for close observation. Twenty-four hours into his admission, his urine output increases to 300+ mL per hour for several hours.

His VS remain normal, and he has no evidence of peripheral edema. His serum sodium on the basic metabolic profile is 154 mEq/L.

Working Dx

This patient has hypernatremia without any evidence of an increased or decreased extracellular volume. The most common cause of this clinical picture is diabetes insipidus (DI), a condition in which there is impaired conservation of free water by the kidney.

Medical Knowledge

DI is a syndrome of excessive excretion of hypotonic urine caused by inadequate release of antidiuretic hormone (ADH; central DI) or unresponsiveness to ADH (nephrogenic DI). ADH is a hormone produced by the posterior pituitary gland that promotes free water reabsorption by the kidney in the collecting tubules. In both forms of DI, the kidney is unable to concentrate sodium. Both forms of DI occur in critically ill patients—central DI is commonly associated with head injury; nephrogenic DI is associated with certain medications and radiocontrast agents.

Because the fluid loss in DI is free water, the tx of DI is to replace the free water deficit. The free water deficit is calculated using the equation above and replaced *slowly* to avoid cerebral edema. If the patient has central DI, vasopressin or its synthetic analog desmopressin (DDAVP) is also given.

Hypervolemic hypernatremia is uncommon, and can result from excess intake of hypertonic fluids. Examples are administration of hypertonic saline or sodium bicarbonate solutions. Usually, the normal functioning kidneys are able to rapidly excrete excess sodium and water. **See Sabiston 5; Becker 6, 34.**

Case 3

A 60-year-old female is admitted for shortness of breath. She has been a heavy smoker for the past 25 years. CXR shows a spiculated mass in the right lower lobe, suspicious for carcinoma. Routine labs are drawn, and the patient is found to have a serum sodium concentration of 129 mEq/L. The patient clinically appears euvolemic.

Working Dx

Managing hyponatremia also involves determining the volume status of the patient. This patient has a low serum sodium concentration in the face of a normal extracellular volume. The two major causes of this state are inappropriate release of ADH and acute water intoxication. Lung cancer can cause paraneoplastic syndromes by tumor production of normally occurring hormones such as ADH. The syndrome of inappropriate ADH (SIADH), which this patient has, can be seen in patients with certain tumors, infections, and recent surgery and is a consideration only when the patient is euvolemic.

Medical Knowledge

Key Points: Checking urine sodium and urine osmolality helps to distinguish between the two causes of euvolemic hyponatremia: SIADH and psychogenic polydypsia (acute water intoxication). In patients with SIADH, ADH is released even when there is no appropriate stimulus (increased tonicity, hypovolemia), resulting in highly concentrated urine (urine osmolality $>$ 300 mOsm/kg H_2O) and hypotonic plasma (plasma osmolality $<$ 290 mOsm/kg H_2O). Acute water intoxication commonly occurs in psychiatric patients who drink enormous amounts of free water in a short period of time. In this condition, the urine sodium and osmolality are low, when the plasma osmolality is normal or low. The tx is fluid restriction and, in severe cases, hypertonic saline.

Critical Care Kernel: Extreme elevations in plasma lipids or plasma proteins can falsely reduce the measured plasma sodium concentration. This condition is called pseudohyponatremia. **See Sabiston 5; Becker 6, 34.**

Case 4

A surgical consult is called for chest tube placement in a 75-year-old male with bilateral pleural effusions. The patient was admitted earlier in the day for an exacerbation of congestive heart failure. He is short of breath, has bilateral crackles on physical examination, and bilateral lower extremity pitting edema. His serum sodium concentration is 130.

Working Dx

This patient has a low serum sodium with an increased extracellular volume, as manifested by the pulmonary crackles and peripheral edema. The patient is in congestive heart failure.

Medical Knowledge

Key Points: Hypervolemic hyponatremia results when there is excess of both sodium and water, but the gain in water is larger than the gain in sodium. The urine sodium can be helpful in determining the cause. In heart failure and hepatic failure, the urine sodium is less than 20 mEq/L. In renal failure, the urine sodium is greater than 20 mEq/L. The tx is diuresis.

The major complication of hyponatremia is cerebral edema, which leads to metabolic encephalopathy and even death. Additionally, another type of encephalopathy, termed central pontine myelinosis, can result from rapid correction of hyponatremia. The neurological consequences are severe and permanent. Therefore, sodium deficits should be corrected slowly over several days with isotonic solutions. **See Sabiston 5, Becker 6.**

Case 5

A 32-year-old male sustained a motor vehicle collision and underwent exploratory laparotomy. His injuries required splenectomy and multiple small bowel resections. He had a large volume resuscitation on hospital days #1 to 3. It is now hospital day #5. His fluid balance for the past 48 hours is positive by 6.5 L. Diuretic therapy with lasix is begun with a good response. On hospital day #7, his serum potassium is 2.8 mEq/L.

Working Dx

This patient's hypokalemia is due to renal losses caused by the administration of diuretics. Loop diuretics, such as lasix, impair the reabsorption of potassium by the kidney.

Medical Knowledge

Key Points: Only 2% of the total amount of the body's potassium is contained in the extracellular fluid, but the relationship between extra- and intracellular potassium concentration remains fixed. Therefore, when plasma (extracellular) potassium is low from potassium loss, there is a large *total body* potassium deficit. The kidney controls the concentration of plasma potassium by regulating its excretion in the urine.

Hypokalemia is defined as a serum potassium concentration less than 3.5 mEq/L. It can be caused by either a shift of potassium from the extracellular to the intracellular compartment or by a decrease in total body potassium.

Differential Dx

Transcellular shift resulting in relative hypokalemia in extracellular fluid (ECF)	Total body potassium depletion
Beta-agonists	Diuretic therapy
Alkalosis	Hypomagnesemia
Hypothermia	Diarrhea
Insulin	

Mild decreases in serum potassium concentration are usually asymptomatic. But severely low potassium levels can cause muscle weakness and change in mental status, as well as cardiac arrhythmias.

If hypokalemia is due to transcellular shifts, the first step in management is to correct the underlying problem causing the shift. If hypokalemia is due to total body potassium depletion, tx consists of potassium repletion.

It is important to remember that potassium concentrations are affected by magnesium concentrations. Often it is difficult to correct a patient's potassium level until magnesium is repleted as well. **See Sabiston 5, Becker 6.**

Case 6

A 45-year-old male is brought into the ED by his family. They report he had been heavily consuming alcohol two nights earlier, and this morning they found him passed out on a chair. He had been there for approximately 40 hours. He is resuscitated and he regains consciousness. His serum potassium is 6.0 and his creatinine is 3.6.

Working Dx

The patient was intoxicated and had been passed out in the same position for about 2 days. He is dehydrated and in acute renal failure, which has caused his serum potassium concentration to rise.

Medical Knowledge

Key Points: Hyperkalemia (serum potassium concentration > 5.5 mEq/L) can result from transcellular shifts or from impaired renal excretion. A simple test to help differentiate the two causes is to check the urine potassium level. When the kidneys are unable to excrete properly, the urine potassium is low (<30 mEq/L). When transcellular shifts are to blame, the urine potassium is greater than 30 mEq/L.

There are several causes of transcellular shift resulting in hyperkalemia. Metabolic acidosis enhances potassium release from cells. Muscle cell death can release large amounts of potassium into the plasma. Several drugs, such as beta-blockers and digitalis, can promote hyperkalemia by transcellular shifts.

Impaired renal excretion of potassium resulting in hyperkalemia can be due to renal insufficiency, adrenal insufficiency, or certain drugs. Adrenal insufficiency resulting in low levels of aldosterone, which normally enhances secretion of potassium by the kidneys, can lead to hyperkalemia. Drugs can commonly cause impaired renal potassium excretion by inhibition of the renin-angiotensin-aldosterone system. Examples include ACE inhibitors, potassium-sparing diuretics, NSAIDs, and heparin.

Critical Care Caveat: If a patient has no clinical reason to be hyperkalemic, it is prudent to call the laboratory to see if the specimen was hemolyzed. Hemolysis of the red cells during or after venipuncture can cause a falsely elevated serum potassium level.

Clinical manifestations of hyperkalemia are rare with a serum potassium less than 6.0 mEq/L. At a potassium level of 6.0 mEq/L or higher, the patient begins to have EKG changes, including peaked T waves, prolonged PR interval, loss of P waves, and widened QRS complexes. Eventually hyperkalemia can progress to arrhythmias, asystole, and death.

The single most important step in the management of hyperkalemia is to check an EKG. If the patient is having EKG changes, the first step is to administer calcium chloride. Calcium directly antagonizes the effects of potassium on cell membranes. If there are no EKG changes, the serum potassium level can be lowered by either enhancing the clearance of potassium or causing an intracellular shift of potassium. Polysterene sulfonate (Kayexalate) binds potassium and enhances excretion through the GI tract. Loop diuretics also enhance potassium excretion by inhibiting the sodium-potassium-chloride pump in the loop of Henle. If the patient is in renal failure, hemodialysis can lower potassium levels within minutes. Maneuvers that cause an intracellular shift of potassium are effective but transient. Insulin administration will lower potassium, but dextrose must be administered at the same time to prevent hypoglycemia. The administration of sodium bicarbonate also drives potassium into cells. **See Sabiston 5, Becker 6.**

Case 7

A 34-year-old female undergoes total thyroidectomy for an enlarging goiter. During her postoperative check she complains of numbness around her mouth. You check a set of labs that are normal, except for a calcium of 6.0 mg/dL.

Working Dx

This patient has hypocalcemia secondary to hypoparathyroidism. A known complication of total thyroidectomy is injury to the parathyroid glands and/or their blood supply. Parathyroid hormone is crucial in regulating calcium levels.

Medical Knowledge

Key Points: 99% of the body's total calcium is found in bone. Calcium is important for vital cell functions, such as blood coagulation, and smooth muscle and cardiac muscle contraction. 60% of the body's circulating calcium is protein bound, and 40% is free calcium. Hypocalcemia that is physiologically important is seen when free calcium is low.

Common disorders associated with hypocalcemia include hypoparathyroidism, alkalosis, blood transfusions, certain drugs, renal insufficiency, and pancreatitis. Alkalosis produces a state in which calcium is more likely to bind to albumin, thereby reducing free calcium. When a patient receives a blood transfusion, calcium binds to the citrate preservative in banked blood. The hypocalcemia is usually transient. Renal failure can produce hypocalcemia because the kidneys are unable to excrete phosphate, and phosphate suppresses the parathyroid glands.

Clinical manifestations of hypocalcemia are in the cardiac and neuromuscular systems. Severe hypocalcemia can result in hypotension, decreased cardiac output, and ectopy. Neurological symptoms include hyperreflexia, seizures and tetanic muscle contraction.

Two clinical manifestations of hypocalcemia are Chvostek's and Trousseau's signs. To test for Chvostek's sign, use your index finger to tap the patient's face just in front of the tragus of the ear, where the facial nerve runs. A positive Chvostek's sign is when the patient's eye, mouth, or nose muscles contract in response. For Trousseau's sign, use a tourniquet or blood pressure cuff to compress the patient's forearm and then release. A positive Trouseau's sign is when the patient's wrist spasms. Both of these are signs of tetany secondary to hypocalcemia. **See Sabiston 5, 37; Becker 6, 32.**

Case 8

A 52-year-old man with a hx of end-stage renal failure on hemodialysis and diabetes mellitus presents to the emergency room complaining of a painful ulcer on the sole of his foot. The pain has caused him to miss his last two dialysis treatments. He is found to have a superinfected diabetic foot ulcer. On his laboratory studies, his white count is elevated to 24,000, creatinine is 12.2 mg/dL, calcium is 6.8 mg/dL, potassium is 6.6 mg/dL, phosphorus is 6.1 mg/dL, and magnesium is 4.6 mg/dL.

Working Dx

The cause of this patient's increased white count is the infection in his foot. The other abnormal lab values can be explained by his history of renal failure with missed dialysis treatments. The kidney regulates potassium, phosphorus, and magnesium levels. For patients with renal failure, dialysis is their only means of excreting these electrolytes.

Medical Knowledge

Magnesium accumulation is common only in patients with renal failure. It usually occurs when exogenous magnesium (i.e., magnesium-containing antacid) is administered. *Magnesium blocks the shift of calcium into myocardial cells, with high magnesium levels causing hyporeflexia and cardiac effects that can progress to asystole and cardiac arrest in extreme cases.* The treatment of mild hypermagnesemia is intravenous fluid infusion combined with loop diuretic therapy. For severe hypermagnesemia, hemodialysis is most effective at decreasing total body magnesium. Intravenous calcium can be given to transiently counteract the cardiac effects of the magnesium.

Hyperphosphatemia results most commonly from renal insufficiency or renal failure. There are very few obvious signs of hyperphosphatemia. To decrease serum phosphorus, we can either enhance excretion via dialysis or promote phosphorus binding with oral sucralfate or aluminum-containing antacids. **See Sabiston 5, Becker 6.**

Chapter 75
Acid-Base Balance

Thomas J. Meyer MD

Cases Considered

1. Sepsis with hypotension
2. NG suctioning in a patient with ileus
3. Confusion and tachypnea in the ED

Speaking Intelligently

When I'm asked to evaluate a patient for an acid-base disturbance, my most important first step is to make sure that I have a simultaneous ABG and basic metabolic panel available. The patient's bicarbonate level alone is insufficient to define the acid-base status. Once the pH is known, I can calculate if the patient is acidotic or alkalotic and the extent of compensation for this abnormality.

Clinical Thinking

I generally follow seven steps when approaching an acid-base problem:

1. **Get the right information:** Obtain an ABG and metabolic panel.
2. **Do the numbers make sense?** The following is a method to check that the numbers are consistent:

$$H^+ \text{ concentration} = 24 \times P_{CO_2}/\text{measured } HCO_3$$

Remember the logarithmic relationship:

H^+ concentration	equals	pH
30		7.50
40		7.40
50		7.30

If the numbers do not make sense, then repeat the labs.

3. **Based on the pH, is the patient acidemic or alkalemic?** This is the primary disorder or process causing the illness.
4. **Can you explain the pH by the P_{CO_2}?** Remember the relationship: The acute change in P_{CO_2} of 10 mmHg causes a reciprocal change in pH of 0.08.

5. **ALWAYS calculate an anion gap:**

$$\text{Anion gap} = Na^+ - (HCO_3 + Cl)$$

Normal anion gap = 12 ± 2.
All causes of an increased anion gap are abnormal!

6. **If there is a metabolic acidosis, is the PCO_2 compensation appropriate?** (Remember, in a metabolic acidosis, the respiratory rate will increase, resulting in a lowering of the PCO_2, in order to drive the pH back toward normal.)

$$\text{Predicted } PCO_2 = HCO_3\ (1.5) + 8\ (\text{variability} \pm 2)$$

7A. **If there is an increase in anion gap, what is the net change or "delta gap"?** For each unit of anion gap increase from 12, there is a unit decrease in HCO_3. Therefore, one can determine what the patient's HCO_3 level was prior to becoming ill. This allows the determination of an acid-base disturbance that may be initially occult. For example, if a patient has an anion gap of 20, and a measured HCO_3 of 24:

$$\text{Delta gap} = 20 - 12 = 8$$

The patient's HCO_3 prior to getting ill was:

$$24 + 8 = 32$$

The patient had a metabolic alkalosis *prior* to getting ill with a metabolic acidosis.

7B. **If the patient has a metabolic alkalosis, what represents a normal respiratory compensation?** In other words, can we predict how high a PCO_2 should rise in the setting of a significant metabolic alkalosis? The change in PCO_2 is 0.7 times the change in the HCO_3. If the HCO_3 is 42, assuming normal HCO_3 is 24, the HCO_3 change is:

$$42 - 24 = 18$$

The PCO_2 change, therefore, is $0.7 \times 18 = 12.6$. Assuming a starting PCO_2 of 40, one would predict that the PCO_2 would rise to 52.6 if the HCO_3 was 42.

Case 1

A 40-year-old male is brought to your ED with a fever of 102 and hypotension. He has lived in an assisted living center since suffering a spinal cord injury from a gunshot 2 years ago. He has a suprapubic catheter that has not been changed in several months.

On physical examination, he is tachypneic, BP is 80/50, and HR is 120. He is diaphoretic. Lung and heart examinations are normal. The abdomen is difficult to evaluate due to the patient's sensory deficit. A suprapubic tube is in place in the lower abdomen. The urine is purulent.

Labs: pH 7.32, PCO_2 24, PO_2 80
Na 128, Cl 100, HCO_3 12, creatinine 3.0

Working Dx
Urosepsis with acidosis; steps in evaluation of the acid-base status:

1. We have the appropriate data.
2. H^+ concentration $= 24 \times (24/12) = 48$. The pH is appropriate.
3. pH demonstrates acidemia.
4. Cannot explain pH by PCO_2—the low PCO_2 would make the pH alkalemic.
   a. The patient has a metabolic acidosis.
5. The anion gap is $[128 - (100 + 12)]$ elevated at 16.
   a. The patient has an increased anion gap metabolic acidosis.
6. The predicted $PCO_2 = [12(1.5) + 8 \pm 2]$ or 26 ± 2.
   a. The patient's measured PCO_2 is 24 and is appropriate for the metabolic acidosis.
7. The change in anion gap or "delta gap" is $16 - 12 = 4$.
   a. The patient's HCO_3 therefore started at $12 + 4$ or 16 before be became ill. This is too low and is consistent with an underlying non-anion gap acidosis that was present before the patient became acutely ill with this acidosis.
   b. Increased anion gap metabolic acidosis due to lactate.
   c. Non-anion gap metabolic acidosis due to chronic renal loss of HCO_3.

The patient in this problem has urosepsis and an increased anion gap metabolic acidosis from an increased lactate. The low PCO_2 is due to the appropriate respiratory compensation to the acidosis. He had a low HCO_3 or a non-anion gap acidosis before becoming ill. This was likely due to chronic loss via the kidney.

Critical Care Caveat: All causes of increased metabolic acidosis are bad! If your patient has an increase in the anion gap, finding out why will dictate therapy.

Case 2

A 45-year-old woman presented to the hospital 1 week ago after a car accident resulting in a subdural hematoma and splenic rupture. She was brought to the OR for splenectomy and developed a postoperative ileus resulting in large NG tube losses. She now has a fever of 101.5 and CXR reveals pneumonia. Her BP is low at 90/50, HR is 115, and RR is 20 on the ventilator.

Labs: pH 7.52, $P\text{CO}_2$ 52, $P\text{O}_2$ 90 on 40% $F\text{IO}_2$
Na^+ 144, Cl 84, HCO_3 42

Working Dx

Ventilator-associated pneumonia with an alkalosis; steps in evaluation of the acid-base status:

1. We have the appropriate data.
2. $H^+ = 24 \times (52/42) = 29.7$. Appropriate for pH.
3. pH demonstrates alkalemia.
4. The pH cannot be explained by the $P\text{CO}_2$. The elevated $P\text{CO}_2$ would result in an acidemia.
    a. The primary problem is a metabolic alkalosis.
5. The anion gap is $144 - (84 + 42) = 18$. This is elevated.
    a. The patient also has an increased anion gap metabolic acidosis.
6. Is the respiratory response or elevation in $P\text{CO}_2$ appropriate?
    a. The $P\text{CO}_2$ will rise 0.7 times the change in the HCO_3. In this case, the HCO_3 change is $42 - 24 = 18$. The predicted rise in $P\text{CO}_2$ is therefore $0.7 \times 18 = 12.6$. The predicted $P\text{CO}_2$ is 52.6 and is appropriate in this patient.
7. The change in the gap is $18 - 12 = 6$. The patient's HCO_3 was actually $42 + 6 = 48$ prior to the development of the metabolic acidosis.
    a. Primary metabolic alkalosis due to Cl loss from NG suction.
    b. Appropriate compensatory respiratory acidosis.
    c. Increased anion gap metabolic acidosis.

Medical Knowledge

In this case, the patient had prolonged NG suction resulting in HCl loss from the stomach leading to a Cl deficiency and increased HCO_3 due to renal absorption. This is a classic cause of nosocomial metabolic alkalosis. Had we not calculated the anion gap, however, we would have missed the increased anion gap metabolic acidosis that was developing in this patient. A useful mnemonic to remember the causes of anion gap metabolic acidoses is **MUDPILES:**

Methanol **U**remia **D**iabetic ketoacidosis
Paraldehyde **I**nfection or INH **L**actic acidosis **E**thanol **S**alicylates

See Sabiston 5, Becker 6.

Case 3

A 24-year-old graduate student is brought to the ED by his family, who found him confused and breathing fast. He had been under stress because of his PhD research, which was not going well. In fact, he was soon to be released from his program because of his research failings. His family thinks he took something in a suicide gesture. They found an empty aspirin bottle under his bed.

The patient was tachypneic and confused. Besides stupor, there were no focal neurological findings. Pupils were not pinpoint and were reactive; lungs clear; heart rhythm normal with no murmurs; abdomen soft and nontender; extremities normal.

Labs: pH 7.54, P_{CO_2} 12, P_{O_2} 106 on room air
Na^+ 140, Cl 106, HCO_3 10

Working Dx

ASA (aspirin) overdose.

Steps in evaluation of the acid-base status:

1. We have the appropriate data.
2. $H^+ = 24 \times (10/12) = 20$. Appropriate for pH.
3. The pH is alkalemic.
4. Can we explain the pH with the P_{CO_2}?
   a. The P_{CO_2} is low, which will raise the pH. However, we would expect the pH to rise higher than 7.54. The change in P_{CO_2} is $40 - 12 = 28$. The pH should rise $0.8 \times 28 = 22.4$. Therefore, the predicted pH should be $7.40 + 22.4 = 7.62$.
   b. In other words, the measured pH is not as high as we would expect from a simple respiratory alkalosis alone.
   c. Is there another concomitant disorder?
5. Does the patient have an increased anion gap?
   a. Yes. The anion gap is $140 - (106 + 10) = 24$.
   b. The patient has a concomitant metabolic acidosis.
6. Since the primary disorder is respiratory alkalosis, the predicted CO_2 step does not apply.
7. The change in anion gap is $24 - 12 = 12$. The patient's HCO_3 was $10 + 12 = 22$ prior to this illness. This is normal.
   Final Assessment:
   a. Respiratory alkalosis.
   b. Increased anion gap metabolic acidosis.

Medical Knowledge

This patient presents with a primary respiratory alkalosis with an underlying increased anion gap metabolic acidosis. This is characteristic of an aspirin overdose. The increased aspirin blood level is a respiratory stimulant and an unmeasured acid at the same time.

Chapter 76
Mechanical Ventilation

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Cases Considered

1. 80-year-old male admitted for an elective laparoscopic cholecystectomy is found to be breathing at a rate of 35 breaths/min.
2. 25-year-old male status-post gunshot wound to the abdomen, transferred to ICU postoperation, needs proper vent settings.
3. 77-year-old female status-post subtotal colectomy for lower GI bleeding is ready for weaning.
4. 42-year-old male status-post motor vehicle collision (MVC) develops distress on the ventilator 4 days after admission.
5. 57-year-old male with pancreatitis and adult respiratory distress syndrome (ARDS).

Speaking Intelligently

I am frequently asked to render pulmonary critical care consultation in the following settings: when the patient requires (1) urgent intubation and mechanical ventilation, (2) adjustment of mechanical ventilation already instituted, (3) weaning from mechanical ventilation, (4) intervention for an acute problem that has developed related to mechanical ventilation, or (5) the development of ARDS. Accordingly, we have set forth consideration of the five patients above to consider how to speak intelligently and how to proceed in each of these contexts.

Clinical Thinking

When encountering the patient with a respiratory problem, consider:

1. The ABCs—airway, breathing, and circulation.
2. Does this patient have a problem that is life threatening?
3. Is the pulmonary dysfunction related to ventilation or oxygenation?
4. What are the underlying problems that have led to these respiratory abnormalities?

Case 1

An 80-year-old male admitted for an elective laparoscopic cholecystectomy is found to be breathing at a rate of 35 breaths/min; he is diaphoretic with nasal alar flaring, he holds onto the side rails of his stretcher; he has rales up to his midchest on auscultation. You find out that he has not taken his furosemide ("water pill") during the past week.

Working Dx

Respiratory distress from pulmonary congestion/volume overload.

You decide to place him on 100% O_2 by nonrebreather mask while you prepare for urgent intubation to reduce his work of breathing. Once he is intubated, you move him to the ICU to complete the evaluation, which will include CXR, EKG, and cardiac enzyme evaluation to assess for possible acute myocardial infarction as a cause of the pulmonary congestion. In addition, you administer furosemide empirically to reduce the pulmonary congestion.

Medical Knowledge

Satisfactory spontaneous breathing requires a patient to:

1. Oxygenate adequately
2. Remove carbon dioxide sufficiently
3. Protect his/her airway

If these three criteria cannot be met, tracheal intubation and mechanical ventilatory support may be required. In the setting of respiratory distress, careful judgment is needed to determine if and when to initiate mechanical ventilation.

Increased work of breathing, also known as *respiratory distress*, manifests with the following:

1. Tachypnea
2. Shallow respirations
3. Use of accessory muscles of respiration
4. Nasal alar flaring
5. Subjective dyspnea

Blood gases, while able to provide objective evidence of distress, are the last parameters to deteriorate in the evolution of pulmonary dysfunction. The decision to intubate and initiate mechanical ventilation should be made on clinical appreciation of respiratory distress. **See Sabiston 24; Becker 11, 12.**

Case 2

A 25-year-old male presents with a gunshot wound to his abdomen. He is intubated and taken to the OR, where his abdominal injuries are addressed definitively by a single resection of his small bowel. He is brought to the ICU on a ventilator at the following settings: assist-control (A/C) mode, RR 12, tidal volume (Vt) 500 mL, fraction of inspired O_2 (F_{IO_2}) 100%, positive end-expiratory pressure (PEEP) 5. He is sedated and paralyzed. Your baseline ABG returns: pH 7.24, Pa_{CO_2} 55 mmHg, Pa_{O_2} 240 mmHg, HCO_3 16 mEq/L.

Working Dx

Acidosis with hypoventilation; acceptable oxygenation.

(Pa_{O_2} : F_{IO_2} ratio 240; see discussion of ARDS under Case 5.)

To correct the acidosis, you increase the RR to 20, which will increase the minute ventilation from 6 to 10 L/min. You also decrease the F_{IO_2} to 50% to minimize the risk of oxygen toxicity.

Medical Knowledge

Modes of Ventilation/Settings

Editor's note: Understanding mechanical ventilation first requires familiarization with the vernacular used in the respiratory care field. A glossary of the different types of ventilatory approaches follows. Note that there are two basic modes of ventilation: **volume limited** (gas flow continues until a predetermined inspired volume is achieved) and **pressure limited** (gas flow continues until a predetermined airway pressure is reached). Following a description of the ventilation modes, primary and secondary ventilatory controls are outlined.

Volume-limited Ventilation

Volume-limited ventilation involves the delivery of gas until a preset tidal volume (V_T) is reached; airway pressures can vary depending on compliance or stiffness of the lungs. Expiration is passive. The following settings vary by how the ventilator responds to spontaneous inspiratory effort.

a. CMV (controlled mechanical ventilation): Provides a preset number of breaths per minute at a preset V_T regardless of patient effort. The ventilator is time-cycled, so it is triggered by passage of a preset amount of time. This mode of ventilation is commonly used in the operating room due to a blunted respiratory effort from general anesthetic agents.

b. A/C (assist-control): Provides a preset V_T whenever a patient spontaneously initiates a breath. In addition, the "control" portion provides a preset number of breaths as a backup in case the patient's spontaneous rate is less than optimal. For each type of breath delivered, whether spontaneously or machine initiated, the tidal volume delivered is constant.

c. **SIMV (synchronized intermittent mandatory ventilation):** The machine delivers a preset number of breaths at a preset tidal volume. If the patient takes a spontaneous breath between machine-controlled breaths, the machine assists with pressure support at whatever preset pressure is programmed into the ventilator (see PSV below). Tidal volumes for these spontaneous breaths are completely determined by how much gas the patient can pull from the ventilator with a given amount of pressure support.

Pressure-limited Ventilation
This mode involves the delivery of gas until a preset peak airway pressure is reached, so the actual volume of gas delivered can vary per breath based on lung compliance.

a. **PCV (pressure control ventilation):** Gas flow is limited by a predetermined airway pressure and terminated after a predetermined duration of time (inspiratory time, Ti). The breathing cycle can be initiated by a patient's inspiratory effort and is also mandated by the physician-determined respiratory rate. In either case once the breath is initiated, the inspiratory flow is rapid to establish the physician-determined pressure (known as the PCV level).
b. **PSV (pressure support ventilation):** In contrast to PCV, there are no mandatory breaths—PSV only supports spontaneous breaths and therefore mandates that the respiratory drive be intact.
c. **CPAP (continuous positive pressure ventilation):** This mode is used as a support for patients who are spontaneously breathing but cannot maintain adequate mechanics and/or oxygenation on their own. Each breath, and its tidal volume, is patient generated. The ventilator provides flow to pressurize the airway in an attempt to recruit and/or maintain open alveoli. CPAP is usually combined with PSV as a specific ventilation strategy or used to wean from other modes of mechanical ventilation. **See Sabiston 24, Becker 12.**

Medical Knowledge

Ventilator Parameters to Set

Primary Controls
To regulate *ventilation*:

a. **Rate:** Start at 8–12 breaths per minute. This machine rate determines the *minimum* number of breaths.
b. **Tidal volume (V_T):** Initially set at 8–10 mL/kg; for patients with Acute Lung Injury (ALI) or ARDS, lower tidal volumes (6 mL/kg IBW) should be used.

To regulate *oxygenation*:

c. **F_{IO_2} (fraction of inspired O_2):** The goal is use the lowest F_{IO_2} possible to establish an acceptable P_{O_2} (generally > 60 mmHg).

Maintaining an $FIO_2 > 60\%$ for > 24 hours places the patient at an increased risk of oxygen toxicity and further lung injury.

d. PEEP* (positive end-expiratory pressure): This represents the pressure in the alveoli at the end of expiration. PEEP keeps alveoli open at the end of expiration, when otherwise they may collapse shut. Closure of the epiglottis normally maintains an intrinsic PEEP of about 5 cm H_2O. Thus intubated patients should be set at least 5 cm H_2O; higher PEEP may be indicated in certain pathological conditions that predispose to closure of alveoli (i.e., ARDS) to maintain oxygenation.

Secondary Controls

a. Inspiratory-to-expiratory (I : E) ratio: Since expiration is due to a passive recoil of the lung and chest wall, it normally takes two to three times longer to fully exhale than to inhale; therefore, initial I : E ratios are set at 1 : 2 or 1 : 3.

b. Inspiratory flow rate (IFR): Represents the peak rate of inspiratory flow. This is usually set at 40–80 L/min. Faster IFR times will lead to longer expiratory times and more time for ventilation; slower IFR will lead to longer inspiratory times and more time for oxygenation.

c. Waveform pattern: The two patterns of gas flow over time that can be set on the ventilator are the *square* or *ramped* waveforms. The square waveform results from the inspiratory flow starting at a high rate that is maintained throughout the inspiratory phase and then it drops off abruptly (resulting in a square pattern on the flow vs. time curve). This flow pattern generally leads to high peak airway pressures and a short inspiration time (Ti). The ramped waveform starts at a high rate of flow then declines in the latter phase of inspiration as the lung fills. This pattern results in lower peak airway pressures and a longer Ti. The ramped pattern most closely represents the flow pattern of spontaneous breathing.

The student must appreciate the interrelated nature of the ventilator parameters. Generally the rate determines the respiratory cycle time (time to complete one breath). Most ventilators will then allow the clinician to choose two of the following co-dependent parameters: IFR, Ti, or I : E ratio. **Most commonly, the physician will determine mode, V_T, rate, FIO_2, and PEEP level.** In most institutions, the respiratory therapist sets the waveform pattern, I : E ratio, and IFR by a predetermined protocol or by bedside assessment of needs. **See Sabiston 24, Becker 12.**

*Though generally described as PEEP (positive end-expiratory pressure), current microprocessor driven ventilators create end expiratory pressure by the application of continuous positive airway pressure (CPAP). As most ventilators and the literature refer to "PEEP," we have maintained this designation throughout this chapter.

Case 3

A 77-year-old female status-post subtotal colectomy for lower GI bleeding is seen on the morning following surgery. She is awake and cooperative and indicates she wants the endotracheal tube out. She is on A/C 12, Vt 450, FIO_2 0.5 and CPAP/PEEP +5; her RR is 14, the SaO_2 is 100%.

Working Dx

Status-post subtotal colectomy, now ready for weaning from the ventilator. I check her strength by asking her to lift and hold her head off the pillow—this simple assessment indicates she has metabolized all of the paralyzing agent used in the OR. I then ask the respiratory therapist to change the ventilator mode to PSV/CPAP. The initial PSV level is chosen in the following fashion: (1) determine desired Vt (usually 7 mL/kg), (2) assess the compliance (volume change/pressure change) measured on A/C, (3) set PSV as the pressure change needed to accomplish the volume change (Vt) at the measured compliance.

Medical Knowledge

Weaning from Mechanical Ventilation

Initially, one looks to wean down the FIO_2 from 100% to 35%–40%, either by monitoring the SaO_2 or by measuring PaO_2 on successive arterial blood gases.

Once FIO_2 is lowered (usually <50%) and oxygenation is stable and acceptable, efforts turn to decreasing the amount of mechanical support provided for ventilation by increasing the patient's contribution to minute ventilation ($\dot{V}_E$) via spontaneous breathing. Certain conditions must be met before weaning may begin, including:

- Resolution of the condition that prompted intubation/mechanical ventilation
- Hemodynamic stability
- SaO_2 greater than 90% to 95%
- The absence of cardiac dysrhythmias
- Unlabored respirations (no use of accessory muscles)
- Acceptable ***weaning parameters***
  - $\dot{V}_E$ less than 10 L/min
  - RR less than 25 breaths/min (most sensitive criterion)
  - Vt greater than 4 to 5 mL/kg
- Acceptable pulmonary mechanics:
  - Vital capacity greater than 10 to 15 mL/kg
  - Negative inspiratory force less than −20 mmHg
  - Rapid shallow breathing index (RSBI*) less than 100 (where RSBI = RR/Vt)

*The RSBI is the most accurate predictor of extubation success.

There is no universally accepted standard approach; therefore, each institution and/or physician may vary in his or her style for weaning patients off ventilators. The goal of a weaning trial is to assess the patient's ability to ventilate (overcome the work of breathing) and oxygenate without mechanical support. Examples of modes of weaning trials include:

1. **PSV with CPAP:** The PSV level is chosen to establish a Vt of 5 to 7 mL/kg; CPAP is usually set at 5. The PSV level is then reduced, sequentially if needed, to 5 cm H_2O. PSV 5 cm is thought to provide the minimum amount of support needed to overcome the additional work of breathing imposed by the endotracheal tube (ETT) and ventilator circuit. After a minimum of 30 minutes at this level, weaning parameters are assessed. When mechanical ventilation has been protracted, resulting in respiratory muscle deconditioning, a longer breathing trial (up to 2 hr) may be prudent.
2. **T-piece trial:** The ventilator is disconnected and the patient is provided only a flow of humidified gas through the tubing for about 30 minutes, after which the weaning parameters are checked. With this method, the patient must overcome not only the intrinsic work of breathing but also the imposed work of the ETT/gas tubing. This is particularly useful in assessing patients with left ventricular dysfunction, whose cardiac output may be augmented by even a minimal amount of positive pressure ventilation. **See Sabiston 24, Becker 12.**

Case 4

A 42-year-old male status-post motor vehicle collision develops distress on the ventilator 4 days after admission. The ventilator is on A/C 16, Vt 800, FIO_2 0.5, and CPAP +5; RR 42, SaO_2 78%, BP 88/62, and HR 137. He is diaphoretic with diminished breath sounds on the right.

Working Dx

Ventilator-induced pneumothorax on the right. I would look for distended neck veins and shift of the trachea to the left to support this presumptive diagnosis. Due to the advanced clinical deterioration, I would perform a needle decompression of the right chest by placing a 16-gauge angiocatheter in the second intercostal space at the mid-clavicular line. With decompression, the cardiopulmonary status improves such that a chest tube can be placed under less duress for definitive treatment of the pneumothorax.

Medical Knowledge

Complications of Mechanical Ventilation

- **Ventilator-induced lung injury (VILI):**
  - **Barotrauma/volutrauma:** Large transpulmonary pressures may induce mechanical disruption of alveoli, creating gross air leaks. These may manifest as pneumothoraces, pneumomediastinum, or subcutaneous emphysema.
  - **Atelectrauma (also known as recruitment-derecruitment):** Mechanical shear stresses imposed on lung tissue through the repeated opening and closing of alveoli can cause damage to of individual alveolar units, resulting in impaired gas exchange.
  - **Biotrauma:** Increased pulmonary stress can induce and release into the systemic circulation various inflammatory mediators (i.e., IL-6, ICAM-1, TNF-α). These mediators, induced by the abnormal ventilatory mechanics, can themselves lead to Acute Lung Injury.
- **Ventilator-associated pneumonia (VAP):** The risk for VAP increases as the duration of mechanical ventilation increases. Early-onset VAP is defined as pneumonia that occurs within 24 to 72 hours after tracheal intubation, and is most often associated with aspiration that occurs during intubation. Causative organisms include oxacillin-sensitive *Staphylococcus aureus*, *Hemophilus influenzae*, and *Streptococcus pneumoniae*. VAP that occurs after this time period is termed late-onset VAP, and is usually caused by more resistant organisms, including methicillin-resistant *Staphylococcus aureus* (MRSA), *Pseudomonas aeruginosa, Acinetobacter* species, and *Enterobacter* species. **See Becker 12.**

Case 5

A 58-year-old, 80-kg male who has had abdominal pain for 3 days was brought to ED by relatives with hemodynamic shock, sepsis, and probable aspiration pneumonia. Laparotomy revealed perforated diverticulitis with diffuse peritonitis, and a Hartman's procedure was undertaken. On POD #2 his ventilator settings are A/C 16, Vt 800, FIO_2 100%, CPAP +5; ABG shows pH 7.32, PCO_2 48, PO_2 51; CXR shows diffuse alveolar infiltrates.

Working Dx

ARDS. The most pressing issue is the profound hypoxemia. While the operation and antibiotics are the most crucial steps in resolution of the septic focus that has created this secondary pulmonary insult, the ventilator settings need to be altered to enhance oxygenation. I would decrease the Vt to 500 (~6 mL/kg IBW), increase the A/C rate to 26, and increase PEEP to +7.5. I would then continue to increase the PEEP by 2.5 cm increments in an effort to decrease the FIO_2 to a less toxic range (goal $\leq$ 60%).

Medical Knowledge

The pathophysiology of ARDS is thought to involve the systemic activation of circulating neutrophils, which adhere to the endothelium of pulmonary capillaries. They release their proteolytic enzymes and toxic oxygen metabolites, resulting in damage to the endothelial barrier, which allows the exudation of fluid and protein-rich debris into the alveoli. This process leads to alveolar collapse, which is more prominent in the dependent portions of the lung. This distribution of disease results in extensive shunt physiology (low $\dot{V}/\dot{Q}$ ratio) and profound hypoxia. Etiologies of ARDS include:

- Pulmonary aspiration
- Hemodynamic shock
- Sepsis
- Pneumonia
- Pulmonary contusions
- Cardiopulmonary bypass
- Intracranial hypertension
- Amniotic fluid emboli
- Long bone fractures that cause fat emboli

Table 76-1 lists the criteria required for the diagnosis of ARDS/Acute Lung Injury (ALI) as defined by the 1994 American-European Consensus Conference Committee.

The mortality rate from ALI and ARDS is 40% to 50% and, interestingly, is often *not* due to recalcitrant respiratory failure but rather to multiple organ failure, or overwhelming systemic inflammatory response syndrome.

While ventilating a patient with ARDS/ALI, one must be cognizant of the potential for exacerbating pulmonary injury; hence, therapeutic strategies have been developed to minimize ventilation-induced lung injury (VILI); this lung protection strategy includes:

- Ventilation with small tidal volume (V_T) (6 mL/kg IBW)—limits stretch of alveoli
- Control of peak airway pressures (<40 cm H_2O)
- Increased rate and PEEP to maintain mean airway pressure—prevents recruitment-derecruitment of alveoli
- Permissive hypercapnia—allows for use of low tidal volumes.

The goals of ARDS management involve (1) the prevention of iatrogenic injury; (2) reducing lung water; and (3) maintaining tissue oxygenation. High levels of PEEP have been used to reduce alveolar trauma from the repeated recruitment and collapse of poorly compliant alveoli. The use of PEEP to recruit and maintain alveoli is done to preserve the ventilation portion of the $\dot{V}/\dot{Q}$ relationship, minimize shunt, and improve oxygenation. **See Sabiston 24, Becker 12.**

Table 76-1 Clinical Criteria for Adult Respiratory Distress Syndrome (ARDS)/Acute Lung Injury (ALI)

Parameter	ARDS
Onset	Acute
Clinical setting	Predisposing conditions (see text)
Gas exchange	$PaO_2/FIO_2 < 300$ (ALI); <200 (ARDS)
Chest radiograph	Bilateral patchy infiltrates
Pulmonary capillary wedge pressure	≤18 mmHg
Lung compliance (C_{eff}) = $\frac{\text{Change in volume}}{\text{Change in pressure}}$	<30 mL/cm H_2O (normal: 50–80 mL/cm H_2O)

Modified from Bernard GR, Artigas A, Brigham KL, et al: The American-European Consensus Conference on ARDS. Definitions, mechanisms, relevant outcomes, and clinical trial coordination. Am J Respir Crit Care Med 1994;149(3 Pt 1):818–824.

Chapter 77
Shock: Principles of Management

Thomas A. Santora MD and Dipin Gupta MD

Cases Considered

1. Shock following gunshot wound to the chest in a 21-year-old male
2. Shock following a motorcycle crash in a 33-year-old male
3. Shock following strenuous exercise in a 57-year-old male
4. An elderly female with mental status changes

Speaking Intelligently

When I'm asked to evaluate a critically ill patient, I always consider the processes that may cause rapid deterioration first—shock physiology is high on that list. If shock is present, the hx of events leading to the patient's presentation will often provide insight into the underlying cause. When considering empiric resuscitation, I find it critical to determine if intrinsic cardiac dysfunction is the cause of the shock state, because *all other causes of shock are initially treated with volume expansion*.

Clinical Thinking

Questions I ask when caring for a patient in the ICU:

- Is shock physiology present in this patient?
- What is the probable classification (etiology) of this shock state?
- What interventions are needed to resuscitate (reverse) this hemodynamic abnormality?
- Will invasive hemodynamic monitoring help in the dx of this shock state? In the management of the shock state?

Shock is a sudden alteration in circulatory homeostasis that results in reduced perfusion of nutrients to organs and the cells thereof. Since living cells require a constant supply of nutrients for ongoing energy production to carry out their respective functions, when the necessary precursors (primarily oxygen) to fuel cellular energy production are not available to the cell, the less efficient anaerobic energy production pathway is used by cells with the production of reduced cellular energy and its end product, ***lactic acid***. If the disruption of perfusion is severe or protracted, even the inefficient anaerobic energy production ceases and the cells lack the ability to produce the energy needed to maintain life-preserving functions. Shock physiology is recognized by the organ compromise that results from reduced cellular function within the respective organ.

The earliest and most common VS abnormality is ***tachycardia***. This finding is nonspecific. ***Hypotension***, generally considered systolic BP less than 90 mmHg, occurs late in the course of the shock state (following 30%–40% blood loss in hemorrhagic conditions; see the ATLS reference for more information). The clinician must be aware of the limitations of VS alone as a monitoring strategy for shock state surveillance. As cellular energy production becomes more dependent on the anaerobic pathway, the production of ***lactic acid*** increases, resulting in a measurable base deficit and ***decreased bicarbonate***. Assessing these parameters may allow confirmation of a shock state.

Case 1

A 21-year-old male is brought to your ED with a gunshot wound to the left chest. Initial VS: BP 110/90, HR 124, RR 28. Your examination shows an agitated, uncooperative male with alcohol on his breath, a small bullet wound of the left chest at the third intercostal space mid-clavicular line, decreased breath sounds on the left, tracheal deviation to the right, and distended jugular veins.

Working Dx

This patient is in shock! He is manifesting this shock state (organ hypoperfusion) by agitation and lack of cooperation (CNS) and VS abnormality (increased HR, RR). Late recognition of shock physiology can result in a dead patient!

Critical Care Caveat: Consider the processes that can kill your patient the fastest and evaluate for them first! The CNS effect of alcohol can be a confounding factor; you must evaluate/eliminate the possibility of shock before attributing the above signs to intoxication.

Medical Knowledge

The etiology of shock can be classified as an abnormality of one of the three basic components of the circulation. The circulation consists of a **pump** (heart), the **conduits** (vessels), and the **blood** (intravascular volume). Classification systems have been devised to provide insight into the underlying causative process or to describe the appearance of the patient on clinical examination (cold vs. warm extremities). Hemorrhagic or hypovolemic shock states result from loss of intravascular volume. Cardiogenic shock results from intrinsic myocardial dysfunction, either ischemic (MI) or nonischemic, or from a functional impairment of the heart due to obstruction of venous return. In vasodilatory shock, dysfunction of the vessels results in impaired distribution of blood to the organs. The vasodilatation results from lack of normal sympathetic tone in neurogenic shock, release of bradykinins and histamines in anaphylactic shock, and an overwhelming cascade of vasoactive cytokines in septic shock. Knowledge of the hx predating the acute events will provide insight into the potential causes of the shock state.

Cold Shock	Warm Shock
Hemorrhagic, hypovolemia	Septic
Cardiogenic	Neurogenic
■ Intrinsic myocardial	
■ Extrinsic (restrictive)	Anaphylactic
■ Tamponade	
■ Tension pneumothorax	
■ Pulmonary embolism	

Definition of Hemodynamic Parameters

In addition to the traditional VS, the following are useful metrics of cardiovascular system function:

1. **Pulse pressure** = difference between the systolic and diastolic pressure—decreased in hypovolemia and increased with aortic regurgitation or sepsis.

2. **Mean arterial pressure (MAP)** = diastolic pressure + 1/3 pulse pressure—represents the true driving pressure for peripheral blood flow, does not change as the pressure waveform moves distally.
3. **Central venous pressure (CVP)** = measured pressure in the right atrium—normal range 1 to 6 mmHg.
4. **Pulmonary artery occlusion pressure (PaOP),** also known as "wedge pressure," = measured pressure in the pulmonary tree when forward blood flow is occluded with a balloon, thus reflecting the pressure in the left atrium/ventricle. When read at the end of diastole, represents the preload pressure of the left ventricle; normal range 8 to 16 mmHg.
5. **Stroke volume (SV)** = volume of blood ejected by the ventricles during systolic cycle—normal range 40 to 70 mL/beat.
6. **Cardiac output (CO)** = SV × HR.
7. **Cardiac index (CI)** = CO normalized to body surface area—normal range 2.4 to 4.0 L/min/m^2.
8. **Systemic vascular resistance (SVR)** = calculated value approximating the afterload against which the left ventricle pumps. SVR = [(MAP − CVP)/CO] × 80; normal range 700 to 1,600 dynes-second/cm^2.
9. **Oxygen delivery (DO_2I)** = rate of oxygen transport in arterial blood; defined as the product of cardiac index and arterial oxygen content (Ca_{O_2}). $DO_2I = CI \times Ca_{O_2} \times 10$, where $Ca_{O_2} = 1.4 \times Hb \times Sa_{O_2}$ [Sa_{O_2} = saturation of oxygen in arterial blood]. Normal range 520 to 570 mL/min-m^2.
10. **Oxygen consumption ($V_{O_2}I$)** = rate of oxygen taken up by systemic circulation—defined as the product of cardiac output and the difference in oxygen content between arterial and mixed venous blood. $V_{O_2}I = CI \times (a - v)\ O_2\ diff \times 10$, where $(a - v)\ O_2\ diff = 1.4 \times Hb \times (Sa_{O_2} - Sv_{O_2})$ [Sv_{O_2} = saturation of oxygen in mixed venous blood (obtained from the pulmonary artery)]. Normal range 110 to 160 mL/min-m^2.

Hemodynamic Profiles: Each category of shock has its own profile of hemodynamic parameters:

Shock State	CO	PaOP	SVR
Cardiogenic	low	high	high
Hemorrhagic	low	low	high
Septic	high	low	low
Anaphylactic	high	low	low
Neurogenic	high/nl	low	low

See Sabiston 24, Becker 11, 12.

Case 2

A 33-year-old male was the helmeted driver of a motorcycle struck by a car. Bystanders report he was thrown 30 feet following impact. Upon EMS arrival, he was unresponsive with agonal respirations. He was intubated and transported with spinal precautions. Upon ED arrival, VS are BP 94/40, HR 52, respirations controlled with an ambu-bag. Upon examination, there are abrasions across the upper abdomen and extremities, equal breath sounds, good heart tones, mild abdominal distention with no bowel sounds, warm, dry, and immobile extremities, and only facial grimacing to painful stimulation.

Working Dx

This patient is in vasodilatory shock. In the context of low diastolic pressure, low heart rate, and flaccid, insensate extremities, the likely cause is neurogenic. In acute injury, the potential for a hemorrhagic component must also be investigated.

Medical Knowledge

Critical Care Caveat: Lack of tachycardia in the setting of hypotension is a frequent indicator of neurogenic shock—the disruption of the spinal cord interrupts the sympathetic cardiac accelerators. One can also be misled by the heart rate in patients on beta-blockade and in the elderly who may have conduction abnormalities that limit increased rate.

In all causes of shock physiology except intrinsic cardiac dysfunction, there is either an absolute or relative hypovolemia. In the case of hemorrhage or hypovolemic shock, volume has been lost from the circulation. In the distributive or vasodilatory shock states, the vasodilatation creates larger capacitance with a resultant relative hypovolemia. In obstructive shock states, the intravascular volume doesn't reach the heart due to elevated juxtacardiac pressures. ***Therefore, the first resuscitative intervention for all shock states except intrinsic cardiac is volume expansion.*** An appropriate fluid challenge consists of 20 mL/kg body weight of an isotonic crystalloid solution (i.e., normal saline or lactated Ringer's) or 7 mL/kg body weight colloidal solution (i.e., Hespan/Hextend or 5% albumin) given rapidly. The goal of resuscitation is to reverse the signs of hypoperfusion. Clinical parameters used to guide the effectiveness of resuscitation include normalization of blood pressure, resolution of tachycardia, improvement in mental status, and resolution of oliguria (urine output > 0.5 mL/kg/hr). **See Sabiston 24; Becker 11, 12.**

Case 3

A 57-year-old male presents with complaint of “an elephant sitting on my chest” following strenuous activity. On examination, he is obviously anxious, diaphoretic, and laboring to breathe. VS are BP 88/64, HR 143, RR 36. Examination reveals confusion, no focal neurological abnormality, rales on posterior chest auscultation, S3 gallop, and cool, clammy extremities.

Working Dx

This patient is in cardiogenic shock from an acute MI. You confirm your suspicion with a 12-lead EKG, which shows new Q-waves and “tombstone” ST elevations (named for their appearance as well as their ominous consequences) across the precordial leads. Interventions to improve the hemodynamics may include (1) intubation and positive pressure ventilation, which will reduce work of breathing (the positive pressure in the chest results in [a] reduced venous return to the right heart, thereby decreasing central congestion, and [b] decreased transmural pressure of the aorta, which results in less impedance to left ventricular ejection); (2) parenteral loop diuretic (i.e., furosemide), which results initially in arterial vasodilatation (decreasing aortic impedance) followed by diuresis (decreasing circulatory volume); (3) nitrate administration (sublingual, IV, or transcutaneous), which results in venous vasodilatation (reducing venous return) and coronary artery vasodilatation (increasing blood flow to the myocardium); (4) administer aspirin and systemic anticoagulation with heparin (decrease propagation of the thrombus in the coronary circulation); and (5) inotropic agents (i.e., dobutamine, milrinone), which stimulate the myocardium to strengthen the force of contraction. *Inotropic interventions should be used cautiously in the setting of myocardial ischemia because they increase myocardial oxygen consumption.*

For intrinsic cardiac dysfunction (most frequently due to loss of >40% of the left ventricle), appropriate interventions deal with increasing the contractile efficacy and/or reducing the impedance for left ventricular ejection. Intrinsic cardiac dysfunction should be considered as a cause of the shock state when the patient presents with a complaint of anterior chest pain (with or without radiation to the left shoulder or jaw), shortness of breath, and diaphoresis. Examination may show distended jugular veins along with an S3/S4 gallop, an EKG with changes of myocardial ischemia (inverted T waves, elevated ST segments, Q waves in leads reflective of the thrombosed cardiac vessel [leads II, III, and aVF for the right coronary artery; V2–V5 for the left anterior descending artery; I, aVL, and V6 for the circumflex artery]). The dx of myocardial ischemia is confirmed by elevated creatinine kinase myocardial band (CKMB) and troponin i.

Systems-Based Practice

Cardiogenic shock in the setting of acute MI is one of the most challenging clinical scenarios in modern medicine. In addition to the above standard interventions, many of these patients will require a revascularization procedure to restore blood flow to the myocardium. Most hospitals have developed a rapid response team that facilitates the above interventions and, when appropriate, proceeds to advanced interventions that include (1) cardiac catheterization with angioplasty/stenting and placement of an intra-aortic balloon pump if the patient remains in shock; (2) emergency coronary artery bypass graft (CABG) procedure; or (3) intravenous thrombolysis, if the above procedures are not available in a timely fashion at a given institution.

Case 4

An 88-year old female from a nursing home presents with mental status changes. Nursing home staff state that over the past week, this hypertensive patient has not eaten much and has become more withdrawn. VS: BP 100/44, HR 96, RR 28, T 94.2. Examination reveals a lethargic female in no distress, warm dry extremities, clear respirations, regular rhythm, right-sided costovertebral tenderness, and a quiet nontender abdomen. Workup reveals a small volume of "dirty" urine with white cell casts on microscopy, WBC 36,000, and blood glucose 377. Dx of septic shock due to urinary tract infection (urosepsis). Despite broad-spectrum antibiotics, IV fluids (lactated Ringer's) and an insulin drip, oliguria and hypotension persist. Insertion of a pulmonary artery catheter (PAC) revealed CO 3.8, PaOP 3, and SVR 650.

Working Dx

Septic shock with intravascular volume depletion. Additional lactated Ringer's challenges (20 mL/kg) resulted in progressive improvement: CO 10.4, PaOP 16, SVR 1,050, BP 146/76, HR 72, urine output 0.7 mL/kg/hr.

Key Points

Invasive hemodynamic monitoring:

- Bedside placement of a pulmonary artery catheter requires waveform analysis for proper placement.
- Cardiac output allows distinction of low-flow (cold shock) states from high-flow (warm shock) states (see Case 1 in this chapter).
- Pulmonary artery occlusion pressure (**PaOP**, previously called wedge pressure) allows differentiation of the two causes of cold shock.

The most useful indication for the PAC is in the distinction of cardiogenic from hemorrhagic/hypovolemic causes of shock and in the assessment of intravascular volume status.

The important distinguishing factor is the PaOP—high in cardiogenic and low in hemorrhagic/hypovolemic causes. Review of the hemodynamic profiles shows that the cold shock states have very different parameters when compared to the warm shock states. Though striking in the differences, the PAC is not often used to make the dx of warm versus cold shock due to the striking differences in the other clinical manifestations; rather, the PAC is used to optimize/maximize cardiac output in the management of the warm shock states.

Medical Knowledge

Think volume first to support hypotensive patients; if hypotension persists following fluid challenge (20–40 mL/kg crystalloid), then vasoconstricting agents such as norepinephrine, epinephrine, neosynephrine, or dopamine may be added.

Critical Care Caveat: Use of vasoconstricting agents to support blood pressure can result in reduced organ perfusion if intravascular volume is not adequate.

Chapter 78
Coagulation and Transfusion

Rohit A. Patel MD and Kevin M. Bradley MD

Cases Considered

1. 22-year-old male for preoperative assessment of bleeding risk
2. 55-year-old female with ongoing bleeding from superficial abrasions after a fall
3. 76-year-old female with a GI bleed and atrial fibrillation
4. 47-year-old male with epistaxis and easy bruising
5. 57-year-old male with bleeding in the setting of severe pneumonia

Speaking Intelligently

Identifying a source of bleeding can be challenging. I try to exclude a surgically correctable cause and always consider the hemodynamic consequences of the bleeding process. The etiology of most disorders of coagulation can be identified by obtaining a pertinent hx, including family hx, review of admission medications, a complete physical examination, and appropriate laboratory investigations.

Clinical Thinking

Achievement of the following specific objectives will help guide your clinical thinking process for coagulation and transfusion issues in the ICU.

1. Describe the normal hemostatic processes.
2. Identify the common tests used in evaluating coagulation.
3. Develop an approach to commonly encountered coagulopathies.
4. Recognize etiologies of thrombocytopenia and describe their management.
5. Be alert to heparin-induced thrombocytopenic thrombosis (HITT).
6. List the blood products available for transfusion and be mindful of the potential complications of each.

Coagulation

Medical Knowledge

The normal hemostatic balance is a physiologic process whereby clotting is promoted at the site of an injured vessel, but prevented in an intact vessel. The normal hemostatic process can be arbitrarily divided into two stages, primary and secondary.

Primary Hemostasis

- Vasoconstriction.
- Activated platelet adhesion to the damaged vessel wall.
- Platelet aggregation—adhesion of activated platelets to each other.
- Platelet adhesion and platelet aggregation together form a platelet plug that seals the damaged vessel and stops hemorrhage.

Secondary Hemostasis

- The platelet plug is stabilized by the deposition of fibrin formed through the activation of the coagulation cascade (can occur via the intrinsic, extrinsic, or common coagulation pathways).

Components of the Hemostatic Process

Extrinsic System
Damaged tissue releases factor III, which (with Ca^{++}) activates **factor VII**, initiating the extrinsic mechanism.

Intrinsic System
Factor XII from active platelets activates **factor XI,** initiating the intrinsic mechanism.

Both active factor VII and active factor XI promote cascade reactions, which activate factor X. The common pathway is the process initiated by activated factor X (Xa), leading to the production of fibrin. Xa activates prothrombin activator. Prothrombin activator converts prothrombin to thrombin, and thrombin converts fibrinogen to fibrin.

Fibrin initially forms a loose mesh, which ultimately forms a more dense mesh under the influence of factor XIII. Platelets and red blood cells become trapped by this mesh and the result is a blood clot.

The intrinsic pathway is tested by measuring the activated partial thromboplastin time (aPTT). The extrinsic pathway is tested by measuring the prothrombin time (PT).

- **Inhibitors of coagulation:** Limit clotting to the vicinity of tissue injury
  - Antithrombin III
  - Heparin cofactor II
  - $Alpha_2$-macroglobulin
  - Protein C and protein S
- **Fibrinolytic system:** The function of the fibrinolytic system is to digest excess deposits of fibrin to prevent thrombosis of the vascular tree. Fibrin degradation products (FDP, also known as fibrin split products [FSP] or degradation dimers (D-dimers) can be measured as an index of fibrinolytic activity. **See Sabiston 6, 24; Becker 8, 9.**

Case 1

A 22-year-old male presents to your office for elective repair of an inguinal hernia.

Working Dx
Routine preoperative evaluation.

Medical Knowledge

In order to evaluate this patient's risk for perioperative bleeding, ascertain pertinent features of the hx and physical examination. Historical features suggesting a bleeding potential include:

- Features of coagulopathy
  - Bleeding into viscera, muscle or joints, gingival bleeding after brushing teeth
  - Bleeding following surgery or trauma
  - Hx that local pressure is ineffective in stopping minor bleeding
- Features of platelet disorders
  - Purpura, petechiae, epistaxis, bleeding from the GI tract or superficial skin defects
  - Bleeding starts immediately after surgery or trauma
  - Hx of drug intake known to adversely affect platelet function (aspirin, motrin, plavix)
  - Hx that local pressure results in bleeding control
- Features of vessel wall abnormalities
  - Recurrent bleeding at a single site
  - Local pressure effective to control bleeding

Physical examination findings suggestive of bleeding diathesis:
- Purpura, bruises, ecchymoses
- Hemarthosis, especially the knees in factor VIII deficiency
- Telangiectasis
- Signs of liver disease
- Hepatosplenomegaly and lymphadenopathy

Initial Laboratory Tests to Assess Potential Bleeding Disorder
Screening blood work includes an activated partial thromboplastin time (aPTT; normal 27–36 seconds), prothrombin time (PT; normal 11–14 seconds; may be expressed as an international normalized ratio [INR], normal 0.9–1.2), and complete blood count (CBC). **See Sabiston 6, 24; Becker 8.**

Case 2

A 55-year-old female with a past medical hx significant for hypertension, diabetes, and coronary artery disease presents with ongoing bleeding from abrasions over her forearms and knees after a slip and fall. Her platelet count was 80,000/mm^3; her coagulation times were normal.

Working Dx
Bleeding from low platelets. Platelet disorders can be broadly classified as **quantitative** or **qualitative**. Quantitative disorders can be evaluated by obtaining a platelet count, whereas qualitative assessment can be made with a variety of functional tests, including a bleeding time, aggregation studies, and clot retraction assessment.

Medical Knowledge

Thrombocytopenia is defined as a platelet count below 100,000 per microliter.

Causes

- Decreased production
  - Aplastic marrow (e.g., drug induced)
  - Marrow fibrosis (e.g., myelofibrosis)
  - Marrow infiltration (e.g., leukemia, myeloma, carcinoma)
  - Substrate deficiencies (e.g., vitamin B_{12} and folate deficiency)
- Increased destruction
  - Nonimmunologic (e.g., vasculitis, disseminated intravascular coagulation [DIC])
  - Immunologic (e.g., viral, drugs, ITP, HIT)
- Hypersplenism (e.g., lymphomas, myeloproliferative disorders, portal hypertension)

Levels of Severity

- 150,000 to 450,000 per microliter = normal
- Less than 100,000 per microliter = thrombocytopenia
- Less than 50,000 per microliter = posttraumatic bleeding risk
- Less than 20,000 per microliter = spontaneous bleeding risk

Generally, a platelet count of 20,000/mm^3 or higher is usually enough to maintain normal coagulation. Oozing in a patient with an adequate platelet count and normal coagulation parameters may be a signal of platelet dysfunction. The administration of aspirin and/or plavix to reduce the risk for MI and stroke puts this population at high risk for platelet-related bleeding. Aspirin causes irreversible platelet dysfunction through the cyclooxygenase pathway. The effect of aspirin may be seen for approximately 7 to 10 days. Platelet transfusion may be necessary in the bleeding patient. Platelet dysfunction caused by other nonsteroidals such as ibuprofen is reversible. **See Sabiston 6, 24; Becker 8.**

Case 3

A 76-year-old female admitted with new-onset rate-controlled atrial fibrillation was started on heparin to prevent systemic embolization. You are called to evaluate her for bright red rectal bleeding. Laboratory results are as follows: Hb 9, platelets 170,000/mm^3, INR 1.0, aPTT > 110. She has known diverticulosis by recent colonoscopy.

Working Dx

Heparin overdose. This patient's hemodynamics should be monitored closely, a large-bore IV access obtained, and blood drawn for type and crossmatch. The heparin infusion should be halted immediately; fresh frozen plasma (FFP) will *not* correct the anticoagulant effect of heparin. Reversal of heparin-induced coagulopathy with the administration of protamine sulfate can be employed when needed.

Case 4

A 47-year-old male presents with spontaneous epistaxis. He also noted easy bruising. On examination he is thinly built with a protuberant abdomen with a positive fluid "wave." He admits to having four to five drinks per day for many years. He has a platelet count of 189,000/mm^3, INR 4.2, aPTT 35

Working Dx

The presence of abdomen protuberance with a fluid wave suggests ascites, which makes cirrhosis and a liver-induced coagulopathy a likely etiology of his bleeding. An elevation in INR without a subsequent rise in the aPTT is often seen. Synthesis of all of the coagulation proteins, except factor VIII, occurs in the liver. As liver disease progresses, the vitamin K–dependent factors (factors II, VII, IX, X) and factor V are the first to show reduced activity. In cirrhotic patients, FFP administration may be used to replace vitamin K–dependent factors, but it is only necessary in the setting of active bleeding.

Case 5

You are called to the bedside of a 57-year-old male, who has been intubated 10 days for severe pneumonia, to evaluate new onset of coffee ground drainage from the NG tube. On further examination, you notice oozing of blood from the nares, as well as some ooze around forearm IVs.

Working Dx

DIC. This patient has multiple sites of bleeding along with sites that have delayed or dysfunctional hemostasis (IV sites, or previously hemostatic wounds). This pathological bleeding pattern along with a hx of an infectious process suggests **DIC,** also known as **consumptive coagulopathy.** The laboratory findings of DIC include decreased platelets, prolonged coagulation times, elevated fibrin degradation assessment, and decreased fibrinogen.

Normal coagulation is usually confined to a disruption in the vascular tree by simultaneous activation of coagulation pathways and inhibitors of coagulation, especially antithrombin III, that limits the clotting process to the vascular defect. DIC results from a pathological stimulus of the coagulation side of this balance that creates a derangement in the control mechanisms, producing overwhelming intravascular thrombosis. As this pathological coagulation progresses, the coagulation factors are depleted and end-organ ischemia may result. In the state of depleted coagulation factors, any subsequent fibrinolytic activity at any wound results in hemorrhage (dysfunctional hemostasis).

Management

DIC is a complication of an underlying illness and not a primary process. Elimination of the underlying cause is paramount (e.g., removal of retained products of conception, tx source of sepsis). In addition, replacement of coagulation factors and platelets may be necessary.

TRANSFUSION

The following blood products are available for transfusion:

- *Whole blood* contains RBCs, plasma, and platelets. Autologously donated blood is the only source of whole blood clinically available today. Donated blood is separated into its component elements for transfusion:
    - *Packed RBCs* are most commonly given to increase oxygen-carrying capacity. Each unit has a volume of approximately 300 mL, of which 200 mL consists of RBCs. A unit of RBCs should raise the hemoglobin concentration by approximately 1 g/dL and the hematocrit by approximately 3%. Packed RBCs are usually given for symptomatic or severe anemia (Hb < 7 g/dL) or to replace blood lost in acute hemorrhage. RBCs have a shelf life of 42 days when refrigerated.
    - *Fresh frozen plasma* (FFP) is separated from blood within 6 hours and contains normal levels of all coagulation factors. Its primary use is in replacement of coagulation factors. FFP is not concentrated and has a volume of about 225 mL. Once thawed, FFP must be used quickly.
    - *Cryoprecipitate* is made from fresh plasma. Factors such as factor VIII, von Willebrand factor, fibrinogen, and fibronectin remain solid when FFP is thawed and can be separated and refrozen. Cryoprecipitate is used mainly for its fibrinogen content and may

also be used in the replacement of specific factors, especially factor VIII.

- *Platelets* are derived from the plasma of donated whole blood. Platelet concentrates have a short shelf life, lasting only 5 days when constant agitation at 22°C is used. The use of platelets is indicated to treat or prevent hemorrhage in thrombocytopenia or platelet dysfunction. One unit of platelets will raise the platelet count by 10,000/μL.

COMPLICATIONS

Transfusion Reaction

- *Acute hemolytic transfusion reaction* is almost always due to ABO incompatibility. The incidence is approximately 1 : 25,000. Most of these cases are due to clerical errors and mishandled specimens. Soon after transfusion the patient may exhibit nausea, vomiting, fever, chills, flank pain, abdominal pain, headache, dyspnea, hypotension, and tachycardia. The classic sign is red urine due to the presence of free hemoglobin resulting from intravascular hemolysis. The Coombs' test is positive, and evidence of plasma-free hemoglobinemia may be noted. Management involves immediate discontinuation of the transfusion while providing crystalloid fluid (to flush the free hemoglobin through the kidneys) and any other necessary cardiovascular or pulmonary support. The reaction should be reported to the blood bank along with a sample of the recipient's blood and the residual product in question.
- *Febrile, nonhemolytic transfusion reaction*s occur as a result of two postulated mechanisms: cytokines from donor leukocytes or recipient antibodies to donor leukocyte antigens. By definition this dx requires a rise in temperature of at least 1°C following a transfusion in the absence of any evidence of RBC hemolysis. Management includes stopping the transfusion, administering antipyretic agents, and sending the appropriate blood samples to evaluate for the potential of acute hemolysis.
- *Transfusion-related acute lung injury* (TRALI) is a reaction of antileukocyte antibodies in the donor blood reacting with the patient's leukocytes. Leukocyte aggregates lodge in pulmonary capillaries and cause alveolitis, noncardiac pulmonary edema, and acute respiratory distress syndrome. The most impressive sign in this reaction is hypoxemia. TRALI is more commonly seen after transfusion of FFP or other products with high plasma content. Management includes stopping the transfusion and providing cardiopulmonary support.

Practice-Based Learning and Improvement

Despite many recent advances in blood and blood banking, the demand for blood products remains high. Frivolous use of blood and blood products should be avoided to preserve this precious commodity as well as to decrease the potential risk of viral transmission and transfusion reaction. We frequently withhold transfusion in anemic patients with a hemoglobin concentration greater than 7 g/dL except in high-risk patients (those with coronary artery or extensive atherosclerotic disease) and those with ongoing blood loss. In these anemic patients, optimization of intravascular volume—as well as nutritional iron supplementation—may help avoid the need for transfusion.

Chapter 79
Infections in the Critically Ill: Principles and Management

Christina M. Rose PharmD, BCPS and Aditi Madabhushi MD

Cases Considered

1. Infection in a 45-year-old male on parenteral nutrition
2. Infection in a 78-year-old female on prolonged ventilation
3. Infection in a 58-year-old female status-post Hartman's procedure for a perforated diverticulum

Speaking Intelligently

When asked to evaluate an infected patient for antibiotic therapy, I always ask, "What are the possible sources of infection?" It is important to determine if the infection is community versus hospital acquired (nosocomial) and if the patient is immunocompetent. Empiric therapy with antimicrobials requires broad-spectrum agents likely to cover the most common pathogens associated with the probable source of infection. In many infections encountered in the ICU, more than one antimicrobial agent will be needed for empiric coverage. Once the source of the infection is identified by cultures with susceptibilities, antimicrobial therapy is reevaluated for a change to a regimen with the narrowest spectrum that provides adequate coverage. Narrow-spectrum antimicrobial regimens minimize the development of resistant organisms. If possible, I like to use antimicrobial agents that are cost effective and have the safest adverse effect profile.

Clinical Thinking

Questions I ask when caring for an infected patient:

1. What subjective/objective information makes me think this patient is infected?
2. What is the possible source(s) of the infection?
3. What are the most common microorganisms that could be causing the infection?
4. What antibiotics would be the best choice to cover the possible causative organisms?
5. Are there any medical/surgical interventions that need to be made to control the source of the infection?

When examining a critically ill patient with an infection, it is important to identify all possible sources of infection. Source control is optimal if the cause of the infection can be eliminated—remove the central line, drain the abscess, excise the contaminated foreign body, surgically debride necrotic or ischemic tissues.

The early signs and symptoms of infection in a critically ill patient may be subtle—solely hyperpyrexia, leukocytosis, or mild tachycardia. Other signs of infection include change in mental status, alteration in glucose metabolism (hyperglycemia), leukopenia, hypothermia, or redness/swelling at a surgical site. Hypotension is a late sign of infection. It is critical to detect early signs of infection and start tx as soon as possible to minimize the systemic consequences.

Patients who develop nosocomial infections are often critically ill and may require transfer to an ICU. Many of these patients have been hospitalized for prolonged periods of time and have received multiple courses of antibiotics. As a result, these patients develop infection caused by multi-drug-resistant (MDR) pathogens or superinfections. Examples of nosocomial pathogens are methicillin-resistant *Staphylococcus aureus* (MRSA), *Enterococcus* species that are resistant to ampicillin and vancomycin (vancomycin-resistant enterococcus or VRE), *Pseudomonas* species, and *Acinetobacter* species. We should choose antibiotics based on local susceptibilities or a hospital-/unit-specific ***antibiogram*** that quantitatively represents the percentage of specific microorganisms that are sensitive to the antibiotic.

Case 1

A 45-year-old 72-kg male with a long hx of Crohn's disease and admissions to the hospital for intractable diarrhea was admitted to the ICU for hemodynamic instability. A central venous catheter (CVC) was inserted for hemodynamic monitoring and TPN. Five days later, he started spiking temperatures to 104.5°F and the WBC count was found to be 35,000/mm^3. Blood, urine, and sputum cultures were taken. The chest radiograph was clear. He was started on vancomycin 1 g IV every 12 hours and cefepime 2 g IV every 12 hours.

Working Dx

This patient most likely has an intravascular catheter-related infection. The CVC was removed.

Medical Knowledge

Intravascular catheter-related infections are a major cause of morbidity and mortality. The most common route of infection for nontunneled short-term catheters results from migration of skin organisms from the insertion site into the catheter tract with involvement of the intravascular portion of the catheter. To make a dx of intravascular catheter-related infection, one of the following should be present:

1. A positive result of semiquantitative (≥15 colony-forming units [CFU]) catheter culture
2. A positive culture result from a CVC and the same positive culture result from peripheral blood

The catheter should be removed and cultured if the patient has erythema or pus overlying the catheter site or clinical signs of sepsis. In patients with fever and no signs of shock, if the blood cultures are negative but the suspicion of CVC infection is high, the catheter can be changed over a guide wire and the distal segment of the catheter sent for quantitative culture. If this culture returns with >15 CFU bacteria, the replaced catheter should be removed. The most common organisms encountered are: coagulase-negative staphylococci, *S. aureus*, aerobic gram-negative bacilli, and *Candida* species. It is strongly suggested that patients with infections due to *S. aureus* and *Candida* species have the CVC removed and if needed changed to a new site following initiation of antimicrobial therapy.

Antibiotic therapy is usually initiated empirically and will depend on the severity of the patient's disease and risk for resistant pathogens. Vancomycin is recommended in areas with a high prevalence of methicillin-resistant *S. aureus*. Broad-spectrum agents may be initiated if the patient is severely ill or immunocompromised. Fungemia should also be suspected in patients not responding to antibiotic therapy, those on chronic parenteral nutrition, those on prolonged courses of broad-spectrum antibiotics, or those who are immunocompromised. **See Sabiston 14; Becker 10, 12.**

Case 2

A 78-year-old female was admitted to the medical ICU with a chronic obstructive pulmonary disease exacerbation. She was intubated in the emergency room and started on nebulized bronchodilators and solumedrol 60 mg IV every 6 hours. Ten days later, while she was still mechanically ventilated, secretions changed to thick and purulent.

Working Dx

You diagnose a ventilator-associated pneumonia (VAP). Since the patient has been intubated and in the medical ICU for more than 3 to 5 days, antibiotic coverage for nosocomial pathogens should be started.

Medical Knowledge

Ventilated patients have a cumulative risk for developing VAP at a rate of 1% to 3% per day ventilated. Studies have shown poor outcomes if the empiric antibiotics do not cover the bacterial pathogen shown to cause the pneumonia. Therefore, a three-drug regimen is recommended to include coverage for methicillin-resistant *S. aureus* and double coverage for gram-negative pathogens, including *Pseudomonas aeruginosa, Acinetobacter* species, *Enterobacter* species, and *Klebsiella* species. Vancomycin plus an antipseudomonal beta-lactam and either an aminoglycoside or antipseudomonal fluoroquinolone (ciprofloxacin, levefloxacin) is the recommended regimen. It is of key importance to send a respiratory specimen for culture from either a deep tracheal aspirate or a bronchoscopy so that antibiotics can later be narrowed to cover the specific organisms that are recovered. **See Sabiston 14, Becker 10.**

Case 3

A 58-year-old woman with no significant medical hx except diverticulosis was admitted to the ICU after a Hartman's procedure for a perforated diverticulum. POD #10, she developed a fever to 101.4°F and leukocytosis with a WBC count of 26,000/mm^3. Physical examination was unremarkable except for decreased bowel sounds and abdominal tenderness; the surgical site was clean. She was empirically started on vancomycin 1 g IV every 12 hours and piperacillin/tazobactam 4.5 g IV every 8 hours.

Working Dx

Peritonitis versus intra-abdominal abscess. CT of the abdomen/pelvis was obtained showing a LLQ fluid collection consistent with an intra-abdominal abscess. A percutaneous drainage procedure was undertaken; within 2 days her toxicity resolved.

Medical Knowledge

Intra-abdominal infection is defined as an inflammatory response of the peritoneum to microorganisms and their toxins, which results in a purulent exudate in the abdominal cavity. Intra-abdominal sepsis ranges from a localized process to a devastating disease that results in multiple organ dysfunction. The most important factor in reducing mortality is *source control*—elimination of the source of infection as soon as possible.

The goals of therapy are to eliminate or control ongoing bacterial contamination with a combination of surgery or percutaneous drainage procedures and appropriate antibiotics. Infections resulting from pathology or injury/perforation of the GI tract frequently involve Enterobacteriaceae species, *Streptococcus* species, *Enterococcus* species, *Escherichia coli,* and anaerobes such as *Bacteroides fragilis.*

Critical Care Caveat: An abdominal CT should *not* be obtained to look for a "collection" in a patient less than 5 to 7 days after abdominal surgery unless there is a strong suspicion of an anastomotic leak. The formation of an abscess usually takes about a week to develop, but fluid is usually seen on scans done early in the postoperative period. Demonstration of this fluid on CT may prompt unnecessary, ill-advised interventions such as antibiotics and/or percutaneous drainage procedures that may lead to MDR infection or iatrogenic injury, respectively. **See Sabiston 14, Becker 10.**

Chapter 80
Nutrition Support in the ICU

Sharon Del Bono RD, CNSD, LDN and Julia M. Toto MD

Cases Considered

1. Nutritional requirements for a 24-year-old male with a cranial gunshot wound
2. Nutrition management of a 73-year-old with cancer cachexia
3. Nutrition support of a 30-year-old female with Crohn's-related enterocutaneous fistula

Speaking Intelligently

When evaluating the nutritional status of an ICU patient, it is essential to differentiate between preexisting malnutrition and acute physiological processes that have nutritional consequences. The decision to provide nutrition support needs to be viewed in terms of risk versus benefit; once benefit is decided, it must be determined which route of administration is indicated. The goal of nutritional intervention is to meet the energy requirements (measured or calculated) while providing enough protein to balance the protein losses of catabolism.

Clinical Thinking

When I'm asked to see a patient for the question of nutritional support, I ask the following questions:

- Is the patient suffering from preexisting malnutrition?
- Is nutrition support indicated and will it improve outcome?
- What is the most appropriate route: enteral or parenteral support?
- What are the nutritional goals?
- How will we assess if the nutritional goals are met?
- What are the potential complications of nutrition support?

Candidates for Nutrition Support

- Patient is hemodynamically stable/adequately resuscitated
- Critically ill patients not expected to eat for greater than 5 days
- Patients with a disruption in the ability to ingest or absorb food

Case 1

A 24-year-old male sustained a gunshot wound to the head and was taken by the neurosurgical team to the OR, where he underwent bilateral decompressive craniotomies. He was transferred in stable, but critical, condition to the surgical ICU, where he required ventilatory support.

Working Dx

Brain injury–induced catabolism that results in acquired malnutrition. An NG feeding tube was placed for the initiation of enteral feeding. Initial nutritional parameters showed his electrolytes, LFTs, and triglycerides to be within normal limits. Albumin was 2.8 g/dL. Prealbumin was 10.6 mg/dL. His usual body weight was 75 kg and his height was 5 ft 9 in (175 cm).

Medical Knowledge

Initial Nutritional Determinations

The majority of critically ill patients simply require 25 to 30 kcal/kg/day. This is a simple method of estimating requirements that is commonly utilized by nutrition support practitioners when formulating the initial nutrition support regimen.

Protein Requirements

In the ICU setting, protein requirements are elevated over the usual requirement of 0.8 to 1.0 g protein/kg/day. Stressed, critically ill patients may require 1.5 to 2.0 g protein/kg/day. Patients who are severely catabolic may require additional protein.

Nutritional Products

After calorie and protein requirements have been determined, a specific prescription for protein, carbohydrate (CHO), and fat can be formulated. Commercial tube feeding formulae vary considerably in how much of these three substrates they contain; TPN solutions can be specifically formulated to meet nutritional needs. **In general, CHO constitutes 60% to 70% of energy needs; fats comprise 20% to 30% and protein the remainder.**

Predicting Energy Requirements

Energy needs vary based on age, sex, body mass (height and weight), presence of chronic illness, and severity of illness. Multiple equations have been developed to predict basal energy requirements; the most widely used tool is the **Harris-Benedict** equation, which depends on sex (males > females), weight, height, and age.

Basal Energy Expenditures (BEE)

Males: 66 + 13.8 (weight in kg) + 5 (height in cm) − 6.8 (age)

Females: 65.5 + 9.6 (weight in kg) + 1.85 (height in cm) − 4.7 (age)

The estimated energy expenditure is obtained by multiplying the BEE by a "stress factor"—approximately 1.5 to 2.0 for most significant disease processes (e.g., acute pancreatitis, sepsis, fistulae). **See Sabiston 7; Becker 7, 12.**

Case 1 Continued

One week later, the patient's **prealbumin** level had declined from 10.6 to 7.6 mg/dL (normal range = 17–40 mg/dL). A 24-hour urine urea nitrogen collection was ordered that showed that the patient was excreting more nitrogen than he was taking in. Thus, this patient was in negative nitrogen balance and therefore was not receiving adequate protein calories. A protein supplement was added to the tube feed order, providing an additional 15 g of protein (roughly 2.5 g N).

Working Dx

Negative nitrogen balance.

Medical Knowledge

Monitoring serum protein levels is commonly utilized in the ICU to assess nutritional status. Concentrations of albumin, prealbumin, and other proteins reflect disease severity and non-nutritional alterations in hepatic synthesis. Serum albumin, prealbumin, and retinal-binding protein are used in clinical settings to assess visceral protein repletion. The serum half-life of prealbumin (~48 hours) makes it the preferred visceral protein to monitor the adequacy of protein provision. Albumin has a half-life of approximately 3 weeks; therefore, albumin is used in the initial nutritional assessment as a reflection of chronic protein-calorie malnutrition (PCM). **See Sabiston 7, Becker 7.**

Case 2

A 73-year-old man presented to the ED complaining of several days of nausea and vomiting. He had not had a bowel movement in 3 days. Further questioning revealed a hx of constipation, anemia, and a 40-pound weight loss over the past 4 months. Obstruction series revealed a complete large bowel obstruction. He was taken to the OR, where he was found to have a large obstructing tumor in the sigmoid colon. A Hartmann's procedure was performed: the sigmoid colon was resected with the formation of an end colostomy. During the operation, a gastrostomy tube was placed for postoperative enteral nutritional support. Initial nutritional parameters were albumin 2.0 g/dL, prealbumin 7.7 mg/dL, and LFTs and triglycerides were within normal limits. Postoperatively, he remained in ventilator-dependent respiratory failure, but had begun weaning trials and was making progress toward extubation. Chronic malnutrition along with acute stress prompted early enteral nutrition support. Electrolytes were checked prior to initiation of tube feeding and were within normal limits. Enteral feeds were initiated. Within 24 hours after the start of feeding the patient's ***potassium*** level was 2.9 mEq/L (normal 3.5–5), ***magnesium*** level was 1.2 mEq/L (normal 1.8–2.2), and serum level of phosphorous was 1.1 mmol/L (normal 3.5–4.5). The patient was tachycardic and had failed that day's ventilator weaning trial.

Working Dx

Refeeding syndrome.

Medical Knowledge

Goals of Initial Nutrition Support and the Refeeding Syndrome

Nutrition support goals in the critically ill include preservation of lean body mass, supporting immune function, and wound healing. In the critically ill patient the goal of nutrition support is maintenance, not repletion. Patients who have protracted malnutrition are at risk for the "refeeding syndrome":

- Etiology: the shift from using stored fat to carbohydrate as the primary fuel source following a period of relative or actual starvation.
- Initiation of nutrition support may cause serum insulin levels to rise which results in intercellular movement of electrolytes for metabolic pathways.
- Serum levels of potassium, phosphorous, and magnesium may decrease to dangerously low levels.

Initial nutrition goals for patients at risk for refeeding syndrome are conservative. Refeeding syndrome can promote congestive heart failure, dehydration, fluid overload, hypotension, prerenal azotemia, respiratory depression, and sudden death. The rule of thumb regarding caloric provision in patients at risk for refeeding syndrome is, "Start low and go slow." Frequent monitoring of potassium, phosphorus, and magnesium with appropriate repletion is crucial.

Despite the conservative starting goal, this patient was experiencing refeeding syndrome. His failure to wean from the ventilator was due to hypophosphatemia, as phosphorus is required to produce the ATP needed to supply energy to the muscles, including the diaphragm. Hypomagnesemia and hypokalemia occur during refeeding syndrome as potassium and magnesium are required for lean tissue synthesis. **See Sabiston 7, Becker 7.**

Case 3

A 30-year-old woman with a history of Crohn's disease has undergone a small bowel resection to relieve obstruction, now complicated by an enterocutaneous fistula. Her care required bowel rest, local wound care, and parenteral nutrition. A central line was placed for initiation of TPN. Her initial nutritional parameters were albumin 3.2 g/dL and prealbumin 10.5 mg/dL.

Working Dx

Protein-calorie malnutrition. The patient's nutritional needs were estimated to be 25 to 30 kcal/kg and 1.5 to 2.0 g of protein/kg. To avoid massive shifts in blood sugar and electrolytes (i.e., refeeding syndrome), the *initial* TPN order consisted of only 150 g carbohydrate and approximately half the protein and lipid desired for her goal TPN regimen.

A new TPN prescription that provided 100% of estimated caloric and protein needs was started on the second day. The carbohydrate in the TPN was increased to 250 g. She remained NPO because of her fistula, and TPN was ordered daily. Triglyceride and LFT levels remained within normal limits during the 3-week hospital stay, and prealbumin levels increased weekly.

The patient was discharged home on TPN. Once the enterocutaneous fistula healed, she was allowed to start eating again, and her TPN was discontinued.

Medical Knowledge

Parenteral Nutrition

Parenteral nutrition is the provision of nutrients intravenously. Parenteral nutrition can be provided via a peripheral line or central line. Peripheral parenteral nutrition (PPN) is appropriate for up to 2 weeks in patients who are not severely malnourished and can tolerate large volumes of fluid. In comparison to total parenteral nutrition (TPN), PPN has a lower concentration of dextrose and amino acids.

TPN can meet 100% of calorie and protein needs. The so-called 3-in-1 TPN formulation (carbohydrate, fat, protein) allows the clinician an almost unlimited ability to vary the 3 substrates to meet nutritional needs. Most TPN solutions utilize concentrated carbohydrate to provide the bulk of the caloric requirement; as such, all TPN solutions are hyperosmolar and must be delivered into large, high-flow central veins.

How to Calculate TPN

Protein	1 to 1.5 g/kg
Calories	25 to 30 kcal/kg, initiate mixture as 60% CHO and 40% fat

First day half fat, half CHO

Indications for Parenteral Nutrition

- Failed trial of enteral nutrition
- When enteral nutrition is contraindicated or the intestinal tract has severely diminished function due to underlying disease or treatment as in paralytic ileus, small bowel obstruction refractory to enteral feeds, mesenteric ischemia, or GI fistula if unable to place access distal to the fistula

Potential Complications Associated with TPN

- Line sepsis
- Central venous thrombosis
- Hyperglycemia
- Elevated lipid levels
- Electrolyte disorders
- Hepatic steatosis
- Cholestasis, gallbladder stasis, cholelithiasis
- GI atrophy
- Impaired immune function

See Sabiston 7, Becker 7.

Chapter 81
Multiple System Organ Failure

Mark J. Seamon MD and Abhijit S. Pathak MD

Cases Considered

1. Multiple system organ failure (MSOF) in a 58-year-old male with acute pancreatitis
2. MSOF in a 22-year-old male after suffering multiple gunshot wounds, requiring massive blood transfusion
3. MSOF in a 75-year-old woman with pneumonia and sepsis following an esophagectomy

Speaking Intelligently

Multisystem Organ Failure
When asked to assess a patient who is likely to have multisystem organ failure (MSOF), I specifically look to uncover any infectious or inflammatory source that may have set off the process. This requires a detailed hx and a complete physical examination. Given the patient's clinical situation, a detailed hx may be difficult to obtain. Accordingly, I make it a point to review all hospital records from this and previous admissions, and I talk to family members who might be informed about recent events. I carefully assess all of the patient's comorbidities, including hx of tobacco (COPD) and alcohol (cirrhosis) use, which may play an important role in ultimate outcome.

Clinical Thinking

Questions I ask myself when caring for a critically ill patient:

- Is this patient in MSOF?
- If so, what was the underlying cause of the MSOF?
- What diagnostic modalities will determine the cause of MSOF?
- How will I treat the underlying cause of MSOF?
- How will I support the organ systems affected by MSOF?

Medical Knowledge

Definition

- Organ dysfunction/failure—altered organ function that requires intervention in an acutely ill patient.

  - Usually results from a pathological amplification of inflammatory cytokines.
  - Infection or systemic inflammation is frequent trigger of this immune response.
- MSOF—results when more than one organ system fails.
  - Infection or sepsis may produce MSOF, but MSOF often occurs without clinically evident infection.
  - In general, mortality correlates directly with increasing number of failed organs.
  - MSOF is the leading cause of late postsurgical or postinjury deaths.

Etiology

- The "two-hit model"
  - Initial insult primes the immune system and inflammatory response.
  - A second insult amplifies the inflammatory response to produce MSOF.

Signs and Symptoms

- Vary with organ systems affected; for example,
  - Neurologic: delirium, coma
  - Cardiovascular: hypotension, tachycardia
  - Pulmonary: tachypnea, hypoxia, ventilator dependence
  - GI: distention, ileus inability to tolerate feeding
  - Renal: oliguria, electrolyte abnormalities, renal failure
  - Hematologic: coagulopathy, anemia, thrombocytopenia
  - Immunologic: sepsis, fevers, leukocytosis or leukopenia

See Sabiston 24.

Case 1

A 58-year-old male with a hx of alcohol abuse is brought to the ED by ambulance after he is found by a family member lying on his floor, confused, and complaining of abdominal pain. Initial VS in the ED: T 102.1, HR 122, RR 28, BP 90/48. Upon physical examination, he is found to be confused but responsive to painful stimuli. His abdomen is diffusely tender, mostly over the epigastrium. Laboratory values are significant for an amylase of 10,000, WBC count 18,000, AST 300, LDH 376, and glucose 310. CXR reveals a left pleural effusion, while a 12-lead EKG is significant for only sinus tachycardia.

Working Dx

Alcoholic pancreatitis. You take a priority approach to resuscitation. First, the airway is assessed—is the patient awake enough to protect his or her airway? Second, two large-bore IVs are placed and IV fluids (normal saline solution or lactated Ringer's) rapidly administered. A Foley catheter is placed to monitor urine output. Only after adequate resuscitation and relative hemodynamic stability should further diagnostic evaluation be pursued. At this time, CT of the abdomen reveals severe inflammation of the pancreas with ischemia and necrosis. With early, aggressive resuscitation, the inflammatory mediators may be minimized and organ dysfunction may possibly be averted.

Medical Knowledge

MSOF, first described in the early 1970s, is a syndrome of organ failure progression. In the past, critically ill patients may have quickly expired, but knowledge and new technology have allowed the sickest patients to live longer than previously possible. Despite these advances in critical care medicine, mortality from MSOF remains formidable at 40% to 100% and is the leading cause of delayed mortality in the ICU.

MSOF is the result of a massive release of endogenous mediators leading to an exaggerated inflammatory response. Although infection and sepsis are often involved, these conditions are not prerequisites. Noninfected tissue injury (e.g., reperfusion of an ischemic limb) may incite this same inflammatory cascade of events, resulting in MSOF. In fact, the antibody-mediated humoral immune system, complement, and fibrinolytic cascades are all crucial in the pathogenesis of MSOF. Macrophages, platelets, polymorphonuclear cells (PMNs), and endothelial cells each contribute to this inflammatory response. PMNs are the first immune cell type to be found at the site of injury. These PMNs release proteolytic enzymes, oxygen radicals, vasoactive substances, and endothelial factors. Proinflammatory cytokines, including tumor necrosis factor-α (TNF-α) and interleukin-1 (IL-1), are released from macrophages early in the pathogenesis of MSOF. Each of these mediators serves to amplify the inflammatory response, ultimately leading to MSOF in susceptible patients.

In the cardiovascular system, these inflammatory mediators are vasodilatory. Increased cardiac output and decreased systemic vascular resistance are common. While the hypermetabolic state results in an overall increase in tissue oxygen demand, cellular utilization and extraction of oxygen are impaired. Plasma volume is depleted as the interstitial space is expanded, leading to decreased central venous pressures and oliguria. In addition to "prerenal" hypoperfusion, oliguria may be due to intrinsic nephron dysfunction and acute tubular necrosis.

The GI system, often called the "motor of multiple organ failure," plays a major role in the pathogenesis of MSOF. Gut organisms or endotoxins may translocate through the epithelial mucosa to neighboring lymph nodes before disseminating throughout the bloodstream. Bacterial translocation may be exacerbated by the hypotension common in MSOF. Systemic hypoperfusion may also result in vasoconstriction of the gut vasculature and ischemia. If the patient is then resuscitated after a prolonged period of time, reperfusion injury and the release of cytokines and toxic oxygen free radicals ensues. The best way to avoid GI dysfunction during MSOF is with adequate nutrition. Ideally, nutrition is provided enterally if the patient is resuscitated and does not require pressors to maintain systemic blood pressure. **See Sabiston 24.**

Case 2

A 22-year-old male with multiple gunshot wounds is brought to the ED by police. He is taken to the operating room emergently, and his right common iliac artery and vein are repaired. He requires 32 units of RBCs during the procedure. On POD #3, his oxygen requirements increase dramatically. CXR reveals bilateral fluffy infiltrates.

Working Dx

Adult respiratory distress syndrome (ARDS).

Medical Knowledge

The lungs are the most common organ affected by MSOF. Pulmonary dysfunction is often the first sign of MSOF; lung injury may either be primary when alveoli are injured (pneumonia, inhalation injury, aspiration) or secondary when inflammatory mediators create capillary endothelial damage (sepsis, transfusions, pancreatitis). Fluid and inflammatory cells enter alveoli, while thrombosis of the pulmonary microvasculature and oxygen free radicals contribute to the dysfunction. Ultimately, hypoxia, ventilation-perfusion mismatch, and a decrease in lung compliance ensue.

As in this patient with multiple gunshot wounds, hemorrhage itself activates the complement cascade, resulting in increased histamine, arachidonic acid metabolites, TNF-α, and IL-1.

Case 3

A 75-year-old woman is admitted to the ICU after undergoing an esophagectomy for esophageal cancer. Her operation has been complicated by an aspiration event during attempts at single lung ventilation in the operating room. She remains intubated 2 weeks after her operation and becomes increasingly febrile, hypotensive, and hypoxic over the next several days. She becomes oliguric, and dopamine is required to maintain adequate blood pressures.

Working Dx

Progressive MSOF.

Medical Knowledge

Two patterns of MSOF are common. In the first pattern, the lung is the primary site of injury. Pulmonary dysfunction is often followed by hematologic abnormalities. Hepatic and renal failure occur late. The second pattern is characteristic of patients with inadequate resuscitation. Lung injury along with early-onset hepatic and renal failure is the rule. In either pattern of organ dysfunction, mortality is related to the number of organ systems affected.

A simple rule of thumb to keep in mind when predicting mortality for patients with MSOF:

- 1 organ system failure: 20% mortality
- 2 organ system failure: 40% mortality
- 3 organ system failure: 60% mortality
- 4 organ system failure: 80% mortality
- Add 20% mortality for patients over 65 years old

If you have had the opportunity to participate in the care of an ICU patient, you are encouraged to review your patient's course in the context of the Competency Self-Assessment Form on page 35, which can also be found as a Word document on the book's Web site at www.studentconsult.com. Pay particular attention to your team's communication with the patient, consultants, nurses, and the patient's family and how this affected patient care. Did the challenge of complex ICU care and decision making stimulate you to expand your medical knowledge?

CRITICAL CARE EXERCISES: Integrating the Management of the Critical Care Patient

Identify and prioritize the clinical concepts presented in the following case presentations. Compare your assessments to those of the invited experts in the field.

Case 1	Identify Major Issues	Prioritize Major Issues
A 63-year-old female alcoholic is brought to the ED with 3 days of abdominal pain and decreased mentation. VS: T 101.4, P 124, BP 80/60, R 32 Physical examination: lungs clinically clear Abdomen: diffuse guarding and rebound Upright CXR → free air Labs: Na 142, Cl 96, K 3.0, HCO_3 16 ABGs: pH 7.30, Po_2 87, Pco_2 36 Albumin 1.9	• __________ • __________ • __________ • __________ • __________ • __________ • __________	( ) ( ) ( ) ( ) ( ) ( ) ( )

Issue (1)	Corrective action:
Issue (2)	Corrective action:
Issue (3)	Corrective action:
Issue (4)	Corrective action:
Issue (5)	Corrective action:

Professor's Assessment

Case 1

Identify Major Issues	Prioritize Major Issues
Hypovolemia	(1)
Respiratory distress	(2)
Sepsis/free air	(3)
Acid-base imbalance	(4)
Hypokalemia	(5)
Decreased mentation, r/o CVA	(6)
Malnutrition	(7)

Case Discussion by Thomas A. Santora, MD, Professor of Surgery, Temple University School of Medicine, Philadelphia, Pennsylvania

This patient has a surgical abdomen that has resulted in septic shock. The most pressing initial issue is the preparation for surgical exploration.

Priority 1: Hypovolemia

Rationale: The visceral perforation has created peritoneal inflammation and fluid sequestration, resulting in intravascular depletion. Replacement of this deficit is crucial prior to exposure to any anesthetic agent, the majority of which result in vasodilatation. If anesthesia is induced in a hypovolemic state, profound hypotension and hypoperfusion may result. One can use the "tilt test" to estimate the extent of fluid depletion. Obtaining a BP and HR in the supine and upright positions is all that is required to perform this simple bedside assessment. When comparing the BP and HR in the upright to the baseline BP and HR in the supine position, the following interpretation is made:

Hx Suggestive of Fluid Deficit	*Tilt Test Result*	**Total Body H_2O Deficit*
No	No changes	0%
Yes	No changes	5%
Yes	HR change >10	10%
Yes	DBP increase >10	15%
Yes	SBP decrease >20 Light-headed	20%

*Total body water is defined in men as 60% body weight (kg), 55% in women.

Corrective Action: This fluid deficit must be replaced with isotonic crystalloids, ideally with an electrolyte composition that resembles normal plasma concentrations. In clinical practice, lactated Ringer's

(LR) is the most commonly available commercial product. In this patient, who is hypotensive on presentation, two large-bore IV lines should be established and the initial fluid challenge should be LR at 20 mL/kg body weight to run as rapidly as possible. Ideally, any established fluid deficit should be replaced in the first 24 hours as follows: the first half of the deficit in 8 hours, the remainder over the next 16 hours. In this patient, the presence of free air and a tender abdomen on examination mandates urgent exploration for source control. This patient should be taken to the OR after resuscitation has taken place to replete the intravascular deficit sufficiently to assure adequacy of organ perfusion. A clinical surrogate measure of organ perfusion is urine output; if urine output is adequate, then the renal perfusion (as well as that of all other organs) is thought to be adequate.

Priority 2: Respiratory Distress
Rationale: The tachypnea seen on presentation is a concern because of impending respiratory distress. This may be a compensation for the metabolic acidosis and the increased carbon dioxide production associated with temperature elevation.
Corrective Action: I would follow the respiratory status very closely, especially as fluid resuscitation is undertaken, to assure no further deterioration. I would not intubate this patient initially, based solely on the elevated respiratory rate. I would be concerned that the combination of the vasodilating effects of induction agents and reduction in venous return associated with positive pressure ventilation in this intravascularly depleted state would result in profound hypotension/hypoperfusion.

Priority 3: Sepsis
Rationale: The presence of free air clearly indicates the need to proceed with abdominal exploration for source control. The patient's hx of alcoholism raises the potential for peptic ulceration in addition to possible colonic sources (diverticulitis, perforated cancer).
Corrective Action: Regardless of source, empiric antibiotics should be broad to cover the Enterobacteraciae species as well as anaerobes. My empiric regimen would be either Unasyn (ampicillin/sulbactam) or Cipro (ciprofloxacin)/Cleocin (clindamycin) in penicillin-allergic patients.

Priority 4: Acid-Base Imbalance
Rationale: The acidosis is an anion gap metabolic process with respiratory compensation. The anion gap $(142 - [96 + 16]) = 30$ is likely due to the hypoperfusion and resultant lactic acid production.
Corrective Action: I would obtain and trend lactate levels to assess the resuscitation efforts. I would use LR for fluid repletion—this crystalloid solution contains 28 mEq of lactate, which is metabolized

to bicarbonate to assist in the buffer base. I reserve bicarbonate administration for severe acidoses (pH < 7.20).

Priority 5: Hypokalemia

Rationale: In the presence of acidosis, the degree of potassium deficit is camouflaged by K^+ movement out of the cells in exchange for extracellular H^+.

Corrective Action: Using LR for the resuscitation fluid, 4 mEq of K are given per liter of fluid administered. In addition, I would replete with KCl in doses of 10–20 mEq in 100 mL D_5W as needed until total body K^+ can be restored.

Priority 6: Decreased Mentation; r/o CVA

Rationale: The mental status in this presentation is most likely the effects of septic encephalopathy. The hypotension raises the potential for global brain ischemia.

Corrective Action: I would trend the neurological examination postoperatively. If mental status is still abnormal 48 to 72 hours after operation, head CT should be performed to look for ischemic changes.

Priority 7: Malnutrition

Rationale: The combination of acute abdominal sepsis, hypoalbuminemia, and hx of alcoholism raises the likelihood of malnutrition (chronic + acquired).

Corrective Action: I would place an enteral access line to allow postoperative enteral feeding.

Case 2	Identify Major Issues	Prioritize Major Issues
A 68-year-old male 3 days status-post repair of a 7-cm abdominal aortic aneurysm (AAA). The patient has become lethargic and complains of abdominal pain and shortness of breath. The nurse informs you of a blood-tinged diarrheal stool. VS: BP 88/42, HR 132, RR 29, oral T 102.3 ABGs: pH 7.33, PCO_2 28, PO_2 64; WBC count 24.6, Hb 9.6, Na 134, K 6.1	• ______ • ______ • ______ • ______ • ______ • ______ • ______ • ______ • ______	( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( )

Issue (1)	Corrective action:
Issue (2)	Corrective action:
Issue (3)	Corrective action:
Issue (4)	Corrective action:
Issue (5)	Corrective action:

Professor's Assessment

Identify Major Issues	Prioritize Major Issues
Respiratory insufficiency	**(1)**
Shock	**(2)**
Acidosis	**(3)**
Infection	**(4)**
Bleeding	**(5)**
Decreased mental status	**(6)**
Hyperkalemia	**(7)**
Malnutrition	**(8)**

Case Discussion by Miren A. Schinco, MD, Associate Professor of Surgery, University of Florida, Jacksonville, Florida

The patient has undergone an AAA repair with subsequent colonic ischemia. This has resulted in fluid sequestration as well as sepsis with hypoperfusion. The most pressing issues are resuscitation to correct the perfusion deficit, evaluation to confirm the dx, and preparation for the patient to return to surgery.

Priority 1: Respiratory Insufficiency

Rationale: The patient complains of shortness of breath. This is likely a result of respiratory compensation to the metabolic acidosis. In addition, fever causing increased metabolic demands may be contributing to increasing carbon dioxide production. Abdominal pain may be another cause of increase in respiratory drive.

Corrective Action: I would intubate the patient at this time to take control of the situation. This will allow better compensation of the metabolic acidosis and will decrease oxygen consumption at a time when supply is low. Also, any further deterioration in respiratory status or decrease in drive from his mental status decline will render the intubation an emergency. Performing the procedure in a more controlled fashion, semi-electively, is optimal.

Priority 2: Shock

Rationale: Changes in blood flow after the aortic procedure have caused a low-flow state to the colon, most likely the sigmoid colon. (When the inferior mesenteric artery is sacrificed during AAA repair, the blood supply to the left and sigmoid colon is at additional risk.) This mesenteric ischemia has caused fluid sequestration resulting in intravascular depletion. In addition, loss of the colonic mucosal barrier dramatically increases the potential for translocation of colonic bacteria with resultant bacteremia and sepsis. This leads to further intravascular fluid loss. Intravascular fluid loss causes predictable hemodynamic changes. The hemodynamic changes in this patient equate to significant volume loss. Correction of the hypoperfusion state with rapid replacement of this fluid deficit is crucial. Ongoing hypoperfusion will result in increased morbidity and mortality. Attainment of euvolemia prior to the induction of anesthesia is essential. Most anesthetic agents are vasodilators, which will cause hemodynamic collapse in the hypovolemic patient.

Corrective Action: The fluid deficit must be replaced with an isotonic crystalloid solution. The options clinically available are LR and normal saline solution (NSS). The former is preferable in this scenario because it more closely approximates normal plasma concentration of ions. It therefore does not cause a non-anion gap hyperchloremic metabolic acidosis as does NSS. This hypovolemic patient should have two large-bore IV lines secured. An initial fluid bolus of 2 L should be given as quickly as possible. After this fluid administration, the patient should be reassessed for further needs. It is likely that the patient will need more volume.

Consideration should be given to placement of hemodynamic monitoring lines to aggressively and efficiently optimize and continuously monitor the patient's volume status and cardiac function. Pulmonary artery catheters placed via the percutaneous approach can provide information about the preload to the heart (wedge pressure and end-diastolic volume) as well as about the cardiac function (cardiac index). While the current hemodynamic picture is likely a result of hypovolemia, intrinsic cardiac dysfunction may become a problem.

Priority 3: Acidosis

Rationale: There is clearly a metabolic process present in this patient. This is due to the hypoperfusion and resultant lactic acid production. The colonic ischemia itself may contribute to this process, but the majority is likely due to the anaerobic metabolism from the global perfusion deficit.

Corrective Action: If the perfusion deficit is corrected, the acidosis should resolve. Lactate levels should be obtained and followed to monitor the adequacy of resuscitation.

When LR is used as a resuscitative fluid, the lactate is converted to bicarbonate (28 mEq/L) by the liver. Despite the theoretical concern for giving an acidotic patient more lactate, in the face of normal hepatic function, conversion to bicarbonate takes place with reasonable efficiency.

Priority 4: Infection

Rationale: The inciting event occurring in this patient is colonic ischemia. Even when the ischemic process is confined to the mucosal layer alone, the barrier that keeps the colonic bacteria in check is breached. This leads to translocation of these bacteria across to the bloodstream. The causative organisms in such infections are gram negatives, anaerobes, and *Enterococcus* species.

Corrective Action: Early empiric coverage of this patient is indicated. Choices of antibiotic coverage of these organisms would include Unasyn (ampicillin/sulbactam) or a fluoroquinolone (ciprofloxacin or levofloxacin) plus Flagyl (metronidazole) in the penicillin-allergic patient.

In addition to tx with antibiotics, ***rapid dx should be made through the performance of a bedside colonoscopy to the level of abnormality, usually in the sigmoid colon. If only mucosal ischemia is noted, then continued ICU care is adequate; however, if the colon appears black, indicative of transmural necrosis, then operative intervention is warranted as soon as the patient can be optimized.***

Priority 5: Bleeding

Rationale: The patient is having bloody diarrhea as there is ongoing mucosal sloughing from ischemia. This does not usually present with a major hemorrhage.

Corrective Action: Hemoglobin and hematocrit should be measured and followed for ongoing losses. Coagulation profile (PT/INR and PTT) should also be checked to ensure no increased risk for ongoing bleeding.

Priority 6: Hyperkalemia

Rationale: This can be due to ion shifts with the metabolic derangement. The increased extracellular hydrogen ion concentration due to acidosis drives movement of H^+ into the cell, which promotes the movement of K^+ out of the cell to maintain transmembrane charge balance.

Corrective Action: The hyperkalemia will resolve with correction of the acidosis. Remember that the LR used for resuscitative fluid does contain potassium and will be providing 4 mEq per liter of fluid. As resuscitation proceeds, this patient should be on continuous EKG monitoring and a repeat K^+ should be obtained.

Priority 7: Mental status changes

Rationale: The mental status changes in this patient are likely multifactorial. Lethargy and CNS depression accompany hypotension and global hypoperfusion as the brain receives less blood flow. In addition, sepsis is associated with a toxic metabolic encephalopathy. Although a cerebral ischemic event is possible in this hypotensive "vasculopath," it is less likely as the patient is not exhibiting lateralizing signs.

Corrective Action: It is likely that his mental status will improve with correction of the perfusion deficit and infection control. I would monitor his mental status carefully. If it does not improve, head CT will be necessary to evaluate for a stroke.

Priority 8: Malnutrition

Rationale: The patient has likely already gone several days without receiving nutrition. In addition, his sepsis will increase his metabolic demands.

Corrective Action: I would place a postpyloric enteral tube (a tube fed through the pylorus into the duodenum or into the small bowel) intraoperatively. Once he is fully resuscitated, enteral nutrition can be started in the early postoperative period. Enteral nutrition cannot be started before the patient is fully resuscitated. When there is relative hypoperfusion, the increased metabolic demands caused by enteral nutrition can be a cause for mesenteric ischemia. I would not use total parenteral nutrition in this patient.

Case 3	Identify Major Issues	Prioritize Major Issues
A 62-year-old male unrestrained driver in a high-speed motor vehicle collision was found to have right-sided abdominal tenderness. VS: BP 76/40, HR 142, RR 25. Focused assessment sonography in trauma (FAST) revealed hemoperitoneum. Exploratory celiotomy revealed extensive bleeding from a large stellate laceration of the dome of the liver. Attempts at controlling the liver bleeding with inflow occlusion (Pringle maneuver) and ligation of specific parenchymal bleeding was only marginally successful. Bleeding appeared controlled with perihepatic packs. Damage control was undertaken. He received 21 L of crystalloid, 18 units packed RBCs, 6 units FFP, and two platelet packs. Upon arrival to the ICU, VS: BP 86/50, HR 138, RR 18 ventilated. Examination revealed a sedated patient with coarse breath sounds, cool, clammy extremities, and minimal urine output. Rectal T 92°F. ABGs: pH 7.18, P_{CO_2} 54, P_{O_2} 49. Lactic acid 3 mmol/L, Hb 9.9 g/dL, PT/aPTT 21/46, INR 2.56, platelets 87,000.	• __________ • __________ • __________ • __________ • __________ • __________ • __________	( ) ( ) ( ) ( ) ( ) ( ) ( )

Issue (1)	Corrective action:
Issue (2)	Corrective action:
Issue (3)	Corrective action:
Issue (4)	Corrective action:
Issue (5)	Corrective action:

Professor's Assessment

Identify Major Issues	Prioritize Major Issues
Shock	**(1)**
Hypoxia	**(2)**
Acidosis	**(3)**
Coagulopathy	**(4)**
Hypothermia	**(5)**
Subsequent surgical intervention	**(6)**

Case Discussion by Lewis J. Kaplan, MD, Associate Professor of Surgery, Yale University, New Haven, Connecticut

This patient sustained blunt abdominal injury leading to hemorrhagic shock, acidosis, coagulopathy, and hypothermia while requiring surgical exploration and packing of a major hepatic injury that likely involves the hepatic veins or the retrohepatic inferior vena cava (Pringle maneuver unsuccessful in controlling hemorrhage). While the educational aspects of this case discussion artificially separate therapeutic interventions into discrete and prioritizable units, in reality most interventions occur simultaneously even if the clinician places more weight on an individual element or a group of elements. This scheme is consistent with the tenet that the more rapidly one ameliorates abnormal physiology, the more likely one's patient is to survive.

***Priority 1:* Shock**

Rationale: Shock is accompanied by inadequate oxygen delivery and utilization at the cellular level; therefore, shock affects every system in the body. Adequate control of hemorrhage is a key element in the correction of hemorrhagic shock. The surgical team believed that hemorrhage was adequately controlled before the patient left the OR in this case, but the clinician must be vigilant for uncontrolled hemorrhage in the postoperative period. Remember that volume expansion commonly increases mean arterial and mean venous pressure, potentially dislodging clots or overwhelming the ability of packs to compress vessels. Rewarming leads to vasodilatation as does reversal of acidosis, potentially leading to hemorrhage from vessels previously constricted. Uncontrolled bleeding in this case may lead to a compartment syndrome.

Corrective Action: Correction of shock should start with plasma volume expansion. Crystalloid options for this therapy include normotonic fluids such as lactated Ringer's solution or Normosol R. Normal saline (0.9% NSS) is to be avoided as large volume resuscitation with this fluid can lead to hyperchloremic metabolic acidosis.

Colloid options for resuscitation include 6% hydroxyethyl starch in a balanced salt solution (Hextend), as well as fresh frozen plasma (FFP). In this case, FFP is ideal as the patient has a coagulopathy from acidosis, dilution (large-volume crystalloid resuscitation), consumption (clotting at the site of injury), and external loss (hemorrhage) of clotting factors. Successful correction of shock requires adequate oxygen delivery to support cellular respiration and oxidative phosphorylation.

***Priority 2:* Hypoxia**

Rationale: Appropriate delivery of oxygen is essential in correcting shock. Oxygen is central in generating ATP during aerobic respiration. Hypoxia principally generates lactate instead of pyruvate at the end of glycolysis, leading to lactic acidosis.

Corrective Active: Shock therapy expands circulating plasma volume, and this in turn enhances pulmonary blood flow. Pulmonary blood flow is critical in offloading CO_2 and uploading O_2. Adequacy of gas exchange also depends on sufficient aeration of the lung such that ventilation and perfusion ($\dot{V}/\dot{Q}$) mismatch is minimized.

***Priority 3:* Acidosis**

Rationale: Acidosis negatively impacts enzyme kinetics. The increased hydrogen ion concentration impairs enzyme systems including ATPases, serine protease-based clotting factors, and all the elements of glycolysis and the Krebs cycle. Thus energy production and utilization and the clotting process are all inefficient. In addition, myocardial contractility is reduced with significant acidosis.

Corrective Active: Several elements come into play in correcting acidosis related to hypoperfusion. Correction of hemorrhage and hypothermia is essential. The fluid selected for resuscitation may exacerbate acidosis if it induces a hyperchloremic metabolic acidosis (NS). In this case the patient arrives at the ICU already demonstrating a hyperchloremic metabolic acidosis (as in this case, with 21 L of crystalloid resuscitation). In such cases there are two general approaches: (1) the provision of maintenance IVF constructed without any chloride (Cl^-), such as D_5W + 75–150 mEq/L $NaHCO_3$; (2) administration of $NaHCO_3$ as an intravenous push, utilized when the pH is <7.25. Of course, correcting pH by normalizing or at least optimizing P_{CO_2} is a complementary measure.

***Priority 4:* Coagulopathy**

Rationale: Clotting depends on an intact clotting system. Since this patient underwent perihepatic packing, those packs will need to be removed once the coagulopathy has been corrected.

Corrective Action: Correcting coagulopathy requires hemorrhage control, elimination of hypothermia, administration of clotting factors, and optimization of cofactors for clotting. Hemorrhage control has been discussed above, while hypothermia correction is discussed below.

FFP is most commonly utilized for the correction of trauma-associated coagulapathy. Activated factor VII (fVIIa) is another therapeutic option. Fibrinogen is an essential element for clotting as well. Fibrinogen levels < 150 mg% are associated with inadequate clotting and may not be corrected with FFP infusion alone; the addition of cryoprecipitate—a blood component product specifically rich in fibrinogen—is recommended.

Clotting is an energy-dependent enzymatic process that is dependent on cofactors for optimal activity. Both calcium and magnesium are essential cofactors in these processes. Calcium chloride and magnesium sulphate are the preferred replacement agents.

Priority 5: Hypothermia

Rationale: Hypothermia reduces enzyme activity. While protective for explanted organs prior to transplantation, and in certain instances of near drowing, total body hypothermia in the setting of hemorrhagic shock is generally deleterious.

Corrective Action: (1) Initial measures include warming the room temperature to reduce ambient heat loss. (2) All intravenous fluids or blood component therapy should be administered via a warming device. (3) Ventilator gasses should be warmed. (4) An active external warming device, such as the Bair Hugger forced air convective warming blanket, placed over the patient supplemented by a water-filled warming pad under the patient, serves to increase core temperature quite effectively. Should more rapid rewarming be required, then cavitary lavage (gastric, pleural space, bladder) using warm lactated Ringer's solution can be performed.

Priority 6: Subsequent Surgical Intervention

Rationale: Subsequent surgical intervention is required to remove the perihepatic packs, search for other injuries, and establish abdominal wall reconstruction. I would also place an enteral access catheter for nutritional supplementation at the same time. The timing of the planned re-exploration depends on successful correction of all of the above conditions.

Corrective Action: The technical details of the surgical procedure that is to follow the damage control laparotomy are beyond the scope of this vignette. In this case, since the injury is presumed to be hepatic vein and/or retrohepatic IVC, the surgeon should plan for the possibility of needing a vena cava shunt to exclude the IVC and liver from the venous circulation to effect repair. In addition, excluding a hepatic arterial injury is critical. Hence a preoperative hepatic arteriogram should be performed.

Multiple methods of restoring abdominal wall integrity are utilized in the late phase of healing for the patient with an open (damage control) abdomen, including primary fascial closure, component separation of fasical parts, permanent mesh, temporary mesh (planned ventral hernia), and acellular human dermis (regenerative tissue framework). Ultimately, the technique selected will depend on the patient's unique geometry and constellation of injuries and the experience of the management team.

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Chapter 82
The Iraq Experiences: Do Competencies Apply in the War Zone?

Paul J. Schenarts MD

Many challenges are faced by a surgeon deployed to a war zone. The competencies codify the basics of appropriate surgical care, but can these standards be achieved while the surgeon is under fire? The purpose of this essay is to discuss the challenges presented in the combat environment.

CHANGING AND CONTRADICTORY RESPONSIBILITIES

The concept of "surgeon as soldier" appears to be a direct contradiction to a physician's professional responsibilities and ethos. Soldiers are charged with enforcing government policy, and if necessary, through the use of lethal force. On the other hand, surgeons are responsible for using skill to preserve life. Another area of potential conflict involves how decisions are made. The military command structure implies rigidity and discipline, whereas advances in surgical science and the conduct of difficult operations are predicated on flexibility and developing novel ways of thinking. Given these apparent contradictions, is it possible for a competent surgeon to also be a competent soldier?

The roles and responsibilities of a surgeon within a war zone may vary significantly depending on the type of mission, phase of the war, and tactical situation. In the early stages of a war, the efforts of the surgeon are typically focused on treating war-related injuries. As the war progresses, the mission may evolve into an effort to win the hearts and minds of the local population by providing basic medical and occasional surgical care. At other times a combat surgeon may find that the tactical situation takes precedence and that he or she is a soldier first and physician second. For example, imagine you are on a convoy to a local village to provide basic health care when you get ambushed with small arms fire and rocket-propelled grenades. As a result, several soldiers are wounded, one critically. Keep in mind, the only thing that denotes you as a doctor is a small medical insignia on your collar that is covered by your body armor. Given this situation, what are your duties and responsibilities to the injured, to yourself, to your family back home, to your fellow soldiers, and to the injured enemy? As a surgeon, should you fire back? How do you balance the tactical situation of fighting back with your responsibility to care for the injured?

LIMITED RESOURCES

It is not surprising that in a war zone, availability of medical resources may be limited. The impact of limited resources during the triage of injured patients is well known to both military and civilian surgeons. However, what effects do limited resources have on the delivery of health care after initial triage? What constitutes effective and appropriate care in this environment? Can civilian standards of care be applied in a combat zone?

Limited resources also impact the military's ability to "win the hearts and minds" of the local, nonmilitary population. The frequently used criterion for emergency care in this population is based on whether the injury or illness is a threat to life, limb, or eyesight. Using this criterion, would you treat a patient with acute appendicitis or pneumonia? To answer this, one needs to consider the natural history of the disease with and without treatment. When treating the local population, one also needs to be mindful of the steps needed after the initial operation. It may be appropriate to proceed with a complex operation on a local national, but then what happens when there is no long-term mechanical ventilation, no system for rehabilitation, or no ostomy supplies? Another factor to consider when determining the appropriateness of care is the sustainability of these efforts. What effect does it have when you undertake therapeutic measures that need to be discontinued when supplies run out or a new unit takes over your area of operation? Is the local population thankful for those you helped or angry because you've given them something only to later take it away? If they become angry, what are the potential results of this anger?

CARING FOR THE ENEMY

Surgeons in civilian practice are duty bound to care for all patients regardless of circumstances that resulted in their injury. It is rare in a civilian setting that a patient represents a direct threat to the surgeon. This may not be true in a combat zone. Given the high level of emotion, personal vulnerability, and the kinship associated with someone wearing the same uniform, there is an obvious temptation to treat your injured soldiers prior to treating the enemy. However, the first and second

Geneva Conventions state that regardless of uniform, a physician is required to triage and treat all patients according to resource availability and standard clinically based criteria. Meeting these standards is a matter of international law and implies that if we treat our captives well then in return our prisoners will also be treated well. Does this treaty apply to nonconventional forces such as insurgents? Should other traditions or oaths guide the surgeon in this setting? Does this imply a compassionate delivery of care, or is the delivery of clinically appropriate care sufficient? Does the stress of personal danger alter the level of compassion, and if so, is that an appropriate response?

THE WAR FIGHTER

Because the object of war is to win through the use of force, the needs of the war fighter (those who do the fighting) frequently take precedence over the medical needs. While the lives of civilian surgeons center on patients, the war fighter is focused on supply of ammunition, protection of the base, intelligence, food, and shelter. In a combat zone, a forward base operates much like a village, in which only a small portion of the population is sick or injured. As a result, the combat surgeon is frequently required to advocate for the needs of the wounded and to advise nonmedical war fighters on medical issues. This requires negotiation skills and the ability to clearly articulate a nonemotional argument. What are some potential solutions when a higher ranking infantry commander wants a surgical team in his area but the actual need for this team is elsewhere? While a civilian surgeon may get angry and "go over someone's head" to seek resolution of a problem, this jumping the chain of command is considered very inappropriate in the military.

AFTER ACTION REVIEW OF PERFORMANCE

Providing medical care under combat conditions can be very complex. However, it is only through a critical evaluation of systems issues and performance improvement that advances in war surgery can occur. The military has a process called the *After Action Report* that can be easily translated into evaluating individual patient care or larger systems issues. This process allows for documentation, so that the lessons learned can be effectively communicated to others. If you were to critique the performance of your team after a mass casualty event in which they treated 16 soldiers with various complex wounds, what measures would you consider? How would you define success?

In conclusion, the combat environment offers many challenges not typically encountered in a civilian practice of surgery, especially role conflict, limited resources, and multifaceted performance review. The clinical competencies do apply in a war zone but may need to be adapted to this unique environment.

Chapter 83
Potential Conflict between Patient Care and Systems-Based Practice Competencies

Donald M. Jacobs MD

You walk into the examination room, introduce yourself to Mrs. Smith and her family, and sit down to begin reviewing the pertinent medical details of Mrs. Smith's condition. This is a familiar encounter in our health-care system that occurs thousands of times per day. In the purest sense, this is straightforward. You are there to serve Mrs. Smith's needs for care, providing appropriate information and arranging for further testing and treatment as required. The patient's expectation is that you will do everything possible and appropriate to treat her without concern for cost. When you are sick, it's no time to start cutting corners, correct? And besides, she's well insured. The cost of her care won't come out of her bank account.

Fortunately for physicians, our role in these encounters is usually pretty clear. But in the real world of health care in the United States, where we have the ability to provide (and charge) much more than we can afford as a society, this is not as straightforward as it may seem. One of our competencies as physicians is to practice systems-based medicine that would have us concerned not only with Mrs. Smith, and all the other patients we will see today, but with the ability of our system to provide care to everyone.

There is nothing more important in health care and health policy than the patient-provider relationship. Hence the dilemma of the individual's need versus the community's need requires conscientious communication and concomitant interpersonal skill. Communicate effectively with your patients, advocate for them with insurers and employers, and be a knowledgeable spokesperson for the vulnerability of the "doctor-patient" relationship in our evolving health system.

In your role as provider, you also take on an important role as teacher: you must be able and willing to explain *why you are not* ordering tests or providing services patients may feel they should have. Those decisions must be based on sound evidence as to appropriate and cost-effective practice. We should be equally forthright with patients regarding care we know they should receive but for which they are denied access because of the limitations of their insurance contract or their lack of health insurance.

One of our most important roles as physicians is to help define and defend the boundaries of appropriate care. Though for most patients we provide and they get what they want, we currently "ration" care in both overt and subtle ways. The United States has the world's most expensive health care system, spending 50% more per capita than the next highest industrial society, yet we fall well behind on many standards of population-based health statistics. Almost one in six of our citizens is uninsured, and countless others are in need of health services but lack citizenship and insurance. Complicating this dynamic is the fact that the U.S. government is paying for about 45% of the $1.6 trillion spent on health care in the United States per year in spite of a national debt (current as of this writing) of $8.5 trillion.

As physicians we must embrace our role in the public debate about how to reduce the cost of health care and provide coverage for everyone. To do that effectively, we need to be willing to discipline ourselves to manage the health-care dollar through an effective, open, and honest balance of patient needs and societal needs. The lack of clarity on that balance, the lack of consensus on an appropriate basic set of health benefits for all, and the badly misaligned economic model of our current system challenge us greatly. But if we as physicians do not step forward to take on this challenge, all the while protecting the integrity of our relationships with our patients, I shudder to think who will and what the results might be.

Discussion Questions

1. Mrs. Smith is 45 years old and seeing you for her newly diagnosed breast cancer. You know her insurer will not pay for bilateral mastectomy with reconstruction for her small unilateral tumor with the opposite breast normal by physical examination and mammography. She would like to have both breasts removed because she is very afraid of getting cancer in the other breast.

   a. What do you tell her about her treatment options? Do you discuss with her all options? Do you describe a subset of options that matches what her insurance covers?
   b. What is your responsibility to assist Mrs. Smith in dealing with her insurer?
2. You are a physician executive CEO of a specialty practice of cardiology. You have six cardiologists in the group, and the majority of revenues come from cardiac catheter–based intervention. The large radiology group in your area just opened a new high-tech imager capable of high-quality and accurate coronary artery imaging in a noninvasive manner. Your community cannot support another such scanner based on anticipated patient need.
   a. What will you recommend to your patients for diagnostic studies when they are referred to a member of your group?
   b. Should the "free market" determine whether a competing scanner should be purchased, even if that may mean underutilization and a poor return on the investment?
   c. What is the community's role in determining the appropriateness of such expenditures?
3. The Centers for Medicare and Medicaid Services (CMS) has just cut back on Medicaid appropriations to the states, and your state has reacted by decreasing eligibility limits, leaving more vulnerable patients and families without coverage.
   a. What is your role, if any, as a physician in affecting public policy on health-care coverage? How might you carry out that role most effectively?
4. Federal Emergency Medical Treatment and Active Labor Act (EMTALA) laws require that emergency evaluation and care be provided to all.
   a. What are the financial and health ramifications of a system based on emergency coverage alone?

Chapter 84
Bloodless Care Medicine: The Intersection of Religion and the Competencies

Philip Craig Wry MD

The intersection of religion and medicine can present physicians with challenges to patient care, professionalism, systems-based practice, and communication. For example, members of the Jehovah's Witness religion hold beliefs that prohibit them from receiving any of the primary components of blood (red blood cells, white blood cells, platelets, and plasma). Those who strongly adhere to their religious convictions would likely refuse a blood transfusion even when faced with death. Jehovah's Witnesses generally accept all other medical treatment and consistently seek quality medical care.

Professionalism necessitates that physicians adhere to ethical principles and demonstrate sensitivity and compassion to diverse cultural and religious patient populations while carrying out their responsibilities with integrity and accountability.

Physicians must be responsive to their patients who are Jehovah's Witnesses by having the integrity to show sensitivity to their patients' religious beliefs even when there may be a conflict with usual medical practice. This can present an ethical dilemma when a physician feels he or she is being expected to deviate from a standard of care (i.e., withholding a blood transfusion that could save a patient's life). The patient's wishes must supersede any self-interest on the part of the physician, such as fear of the patient's death or legal ramifications. The physician demonstrates respect for the patient by presenting risks but avoiding repetitive discussion of outcomes involving the use or nonuse of blood products.

On a personal level, I have had patients die who might have survived if blood had been given. In some cases I received several letters from family members *thanking* me for allowing their family members to die with the dignity of being able to adhere to their religious convictions without being questioned and reminded that death could have been avoided.

Physicians managing a bloodless care patient must change their clinical practices. A focused history of anemia, congenital or acquired bleeding disorders, abnormal bleeding, and end-organ diseases such as hepatic or renal dysfunction is taken. The practitioner must ask about medications that affect coagulation such as aspirin, NSAIDs, warfarin, heparin, Plavix, vitamin E, and β-lactam antibiotics. The family history should include questions about hereditary bleeding disorders and abnormal bleeding. A careful physical examination should look for purpura, petechiae, ecchymosis, telangiectasia, hepatomegaly, splenomegaly, signs of vitamin deficiencies, and sequelae of renal or hepatic disease.

Erythropoietin, the principal regulator of erythropoiesis, is one of the best known and most useful advances in blood conservation medicine. Erythropoietin should be considered in all bloodless care patients for whom anemia or blood loss is an issue.

There are many advances in the surgical and anesthetic management of the bloodless care patient that optimize blood conservation.

Procedures as extensive as liver transplants can be performed without allogenic blood transfusion. New advances include minimally invasive laparoscopic, endoscopic, laser, transcatheter, embolization, and angiographic procedures, as well as off-pump cardiac revascularization, cell saver, autotransfusion pleurvacs, and acute normovolemic hemodilution.

Special instruments such as the harmonic scalpel cut and coagulate at the same time. Topical agents, tissue adhesives, and fibrin glues reduce blood loss. Medications that enhance clotting can be extremely useful in bleeding patients. Aprotinin (Trasylol), aminocaproic acid (AMICAR), desmopressin acetate (DDAVP), tranexamic acid, recombinant factor VIIa, vitamin K, and vasoconstrictors are considered acceptable by many Jehovah's Witness patients.

Hospital and ICU management of the bloodless patient focuses on limiting iatrogenic blood loss. Only essential blood tests should be performed, pediatric-sized tubes used, and multiple tests done per sample. Inline, closed-system sampling devices eliminate discard waste. Point-of-care microsampling equipment, pulse oximeters, and early removal of arterial and central venous catheters have been used to reduce iatrogenic blood loss.

A multidisciplinary team approach is essential when treating bloodless care patients. This approach requires effective **interpersonal and communication skills** that result in accurate and respectful information exchange among professionals as well as with patients and their families.

This approach includes many services, including the bloodless care coordinators, consulting physician subspecialties, operating room staff, and phlebotomists. As a critical care consultant, the challenge of coordinating and minimizing blood draws as requested by multiple consultants is a daunting task. One must take on the responsibility of being the "gatekeeper" for unnecessary blood sampling.

Numerous local, international, and online resources are available to physicians who care for patients whose religious beliefs prohibit them from receiving blood. Hospital Information Services supervises an international network of Hospital Liaison Committees for Jehovah's Witnesses; currently there are some 120 such committees in the United States and 1,600 worldwide. The office of this patient and physician support service maintains an extensive database of articles from respected journals on medical alternatives to blood transfusion. These committees are made up of selected ministers who provide support at no charge and can be called upon day and night (phone: 718-560-4300).

The Society for the Advancement of Blood Management (SABM, www.sabm.org) and The Network for Advancement of Transfusion Alternatives (NATA, www.nataonline.com) are organizations composed of both physician and nonphysician members. These organizations hold national meetings and provide forums for presenting research and disseminating clinical experience. Another resource related to blood conservation and transfusion alternatives is www.noblood.com.

Discussion Questions

1. What actions are important to ensuring that you, as a physician providing care, are respectful of your patients' religious beliefs?
2. What biases do you possess that may affect your professional behavior when working with patients whose religious beliefs are in opposition to your medical decision making?

Chapter 85
A Patient's Perspective

Linnea S. Hauge PhD

It wasn't the typical ceremony to celebrate an employment anniversary. Seven years of working with surgeons as an educational specialist was being commemorated with, perhaps fittingly, an operation . . . *my* operation. More than once during my tenure in the surgery department, I had joked about my need for a strong sedative. Now, in the preoperative holding area, a novice anesthesiology intern was delivering a dose of Demerol to me via one of his first IV placements. He was generous in his responses when I queried him about his experience. A surgical intern came to retrieve my eyeglasses, followed by a senior resident who easily managed to take care of his preoperative responsibilities while giving me the update on the schedule and easing my anxiety. It seemed hard for them to believe that someone they knew, someone so healthy, was undergoing a lumpectomy and axillary lymph node dissection for breast cancer. It was hard for me to believe, too. But my experience as a patient has encompassed some of the best lessons of my young career in surgical education.

I have always been extremely fortunate in that my family and I enjoy excellent health, and, perhaps more important, I recognized the value of good health. My family and friends withstood my reminders about eating well and exercising. Despite the fact that my academic preparation had taken place in the discipline of exercise and sports science, it wasn't until my foray into surgical education that I truly appreciated my good health. The first operation I observed involved a 12-inch square piece of mesh, used to repair recurrent hernias on an obese woman. Her abdominal muscles were no longer strong enough to serve their intended function. I recall my amazement at this surgical substitute for "abs." It seemed like another example to me of how medical advancements were reinforcing a sedentary lifestyle.

I should note that my experience as a patient was likely tempered by my role as a faculty member at Rush. One of my best friends delivered the news about my diagnosis. It should have been recorded for future surgeons to view as a model of excellence in how to break bad news to a patient. Despite the challenges that come with a diagnosis of breast cancer, it was an incredibly valuable learning experience to be a patient and to see firsthand what is important to patients and their health care experience. I observed others' values about their health and the often-overlooked benefits that come with good health: walking wherever you want; being "in control" of your schedule because you don't need to see a doctor, get a treatment, or rely on someone else to take you somewhere; being able to exercise without limits; and enjoying your favorite foods.

I observed the importance of clear, factual, and respectful communication, from the front line clerks to the physicians of record. For many of your patients, it is most likely the first time that they are going through the health care system where waiting for a CT or getting radiation requires specific instructions for each step of the process. As a health care worker, you may repeat certain phrases or messages several times a day, resulting in a rote behavior that sounds detached in its delivery. It is important that you communicate with each patient with a level of compassion and patience that recognizes that this is the first time the patient is hearing your critical information. Members of the front line of medicine—clerks, coordinators, reception workers—are particularly important in setting the tone and imparting fundamental information in this communication process.

The need to complete radiation treatments every day was a seemingly small commitment for me because I worked in a hospital, but I quickly grew to appreciate the difficulty that a more typical patient would face. Commuting to the hospital on a daily basis can be exhausting, especially when it involves family members and travel assistance. It became clear to me how critical it is for health care professionals to understand the context in which patients are receiving care and managing their disease.

One of the most valued characteristics of medical and surgical training—experience—can sometimes be a hindrance to compassionate communication. The more patients and conditions you see, the more desensitized you typically become. Some desensitization is necessary to be able to perform effectively, but too much desensitization can interfere with your effectiveness to provide optimal patient care. As you progress through your training, identify resources and strategies that can assist you in balancing the value of experience with the compassion that came with caring for your first patient.

Discussion Questions

1. How could health maintenance organizations better align their services with the maintenance of their clients' health and well-being?
2. What is health? What is wellness? How can physicians impact patients' beliefs and practices about health and wellness?
3. Imagine that you are a patient just diagnosed with cancer who is proceeding through the workup process. What would be important to you in your interactions with each health care worker you encounter?
4. As a physician, how can you impact the quality of interactions that each patient experiences with all health care workers?

Chapter 86
On CABGs and Competencies

Barry D. Mann MD

When I began developing *Surgery: A Competency-Based Companion,* I didn't expect that I would undergo a coronary artery bypass graft (CABG) while the book was being edited. In the 31 years since my first day as a surgical intern, I have been in an operating room as surgeon or assistant at least 10,000 times; my CABG was my first time as a patient. This experience has given me a new perspective on the competencies and their importance. For each competency, I offer insight gained as a result of my recent experience as a surgical patient.

"Hi, Barry. I realize you're probably out partying, but I just want you to know that I'm going to take good care of you tomorrow, so get a good night's sleep. Everything will be fine. See you in the morning."

What a comforting message to have received on my answering machine the night before surgery! I subsequently learned that Dr. S. telephones all his patients. I wasn't singled out because I'm a colleague. Need I say anything more about the importance of **interpersonal skills and communication?!**

The essence of **practice-based learning and improvement** is to utilize mechanisms of reflection and evaluation in the everyday practice of surgery. One must be ever-vigilant for new insights and take them whenever and however they may present themselves. My new insight, understanding the power of denial, came on retrospection about how long it took *me* to seek a medical workup. For several years, I had been aware of a "feeling of doom" which I could bring about on the treadmill at increasingly slower speeds. Yes, this is the big D of *denial*—and I now realize its power. Having spent much of my career with a particular interest in breast surgery, at least once a year I would be faced with a woman presenting for medical advice with a huge, fungating breast mass. I have found myself quietly wondering, "What was this patient thinking?" I now understand more clearly that denial is not wanting to face where a problem is likely to take you. Having a strong family history of coronary disease and hypercholesterolemia, I knew where this was going—but I was just not prepared to face it. Fortunate to have had no myocardial damage, I now realize the folly of my denial and the extreme and unnecessary risk I had taken. My experience as a patient has served as a powerful mechanism for reflection on my own surgical practice. A deeper understanding of my own denial has helped me identify and respond to denial in my patients.

Once I had overcome the power of denial, I entered the **system**, and I did so with a different perspective from most patients. Knowing I would fail any active stress test, I convinced my cardiologist to go directly to CT-angiography as a prelude to cardiac catheterization. In addition to showing near complete occlusion of the right, left anterior descending, and the circumflex arteries, CT-angiography demonstrated two nodules on the liver (which appears at the lower portion of the CT-angiogram) that could not be characterized (cystic vs. solid) based on the CT-angiographic images. Until MRI was performed the next morning demonstrating benign cysts, I feared, of course, that my fate could have been much worse than simply requiring a CABG. Being an "insider" in the hospital system, I was able to expedite my care and had to struggle with uncertainty about the severity of my diagnosis for only about 20 hours. I recognize that this is not the typical patient's experience, and I have become more cognizant of the anxiety produced by the usual waits our patients endure during the evaluation process. My experience as a patient has sensitized me to the need to make the **system** work as effectively and efficiently as possible for my own patients.

Advancements in **medical knowledge** have a daily impact on physician practice and patient care. The **medical knowledge** acquired by my colleagues who routinely perform off-pump bypasses surely made my trip through recovery much easier. If **medical knowledge** is the frame of the **patient care** fabric, surely the fabric is woven by the dedication, compassion, and professionalism of the nurses. I am grateful for their skill and expertise, as a patient and a colleague. Their excellence reinforced for me the value of every team member's role in providing optimal patient care.

Years ago, as a surgeon in training, I learned *about* the CABG, an exciting new treatment in coronary artery disease. Decades later, as a patient, I would learn *from* a CABG important lessons about patient care.

Chapter 87
Business Challenges to Our Professionalism

Robert E. Booth, Jr. MD

Professionalism is the defining aspect of an occupation that implies mastery of a complex body of knowledge and skills. It also presumes a commitment to competence, integrity, morality, and altruism over self-interest as well as a contract with society to guarantee these qualities.[1]

Many physicians chose a career in medicine presuming they will enjoy relative autonomy in their actions and decisions on behalf of their patients. Today this privilege is in danger of being eroded by external pressures—largely economic and legal—that threaten our professionalism. The patient-physician relationship has deteriorated, the trust of the public has been undermined, academic and educational vehicles have been compromised, and our professional societies have become but a passive voice in the policing of our own profession.

The greatest and most immediate of these economic pressures threatening our professionalism is the relentlessly declining reimbursement for medical care mandated by the external agencies that now control the business of medicine. Medicare, for instance, has been on a decremental reimbursement scheme since 1991, paying less each year for procedures that are better, faster, and more enduring. This is frequently a discouragement to those who continue to strive to provide that care.

For surgeons attempting to define their style of practice and maintain their professionalism, multiple external economic challenges remain. How to negotiate with an HMO, for instance, is a challenge. HMOs are interested in negotiating with physicians who have an established, large-volume practice. Beginning your practice, you may be at the mercy of an HMO, whose reimbursements are traditionally a fraction of Medicare. Dropping out of mandated reimbursement schemes is one strategy; however, this seems inherently anti-Hippocratic to most altruistic physicians. Nonetheless, some physicians believe that this strategy may be their only option for fiscal survival.

The *Stark law* prohibits physicians from making referrals for a “designated health service,” payable by Medicare or Medicaid, to an entity with which the physician has a financial relationship. This law prevents a physician, for example, from referring a patient for an x-ray to a facility in which he has any financial interest. This law is evidence of growing public mistrust of physicians.

Another challenge born of economic bankruptcy is the “pay-for-performance” concept of medical reimbursement based on outcomes. Outcomes are important; however, the instruments for outcome determination are still in their infancy and currently have more to do with patient satisfaction than true medical improvement. Since medical economics is currently a “null sum” game, it is difficult to believe that increased pay will be afforded to those who do a better job. The publication of physician outcomes in newspapers and magazines, as has occurred in the state of Pennsylvania, can have damaging and unintended consequences. Surgeons may consciously avoid risky or complicated procedures that they might otherwise have performed for fear of tarnishing their outcome score and their resulting income stream. This is another example of how a well-intentioned policy, driven by economics, has unintended consequences.

The relationship with the medical industry is yet another interface between professionalism and economics. Physicians who design new instruments or devices and are appropriately rewarded for their intellectual property and innovation have recently come under greater scrutiny for "conflict of interest." With the steady decline of national research funding, much of the technological advancement in our profession comes from the medical industry, and the intersection of industry and medicine will continue to be important to medical innovation.

One final concern is the rise of medical advertising. Advertising by physicians, which used to be taboo, is now increasingly popular. The most aggressive medical practices produce educational seminars and infomercials, and use billboards, newspaper ads, TV and radio spots, and direct mailings to advertise their services. Claims and inducements are cleverly worded to emphasize only the positive, and in many instances constitute an embarrassment to the professionalism that once distinguished us.

The greatest challenge to both physicians and society remains the current malpractice environment. Its economic roots lie in the promise of obscene rewards for patients and their attorneys for the misfortunes and maloccurrences that will forever plague interactions between biology and technology. Currently, only 38 states have adopted tort reform. Without it the excessive financial awards and the consequences they engender will persist. Concerned and altruistic physicians must unite to resist the economic and political challenges that threaten our profession and our professionalism.

Reference

1. Cruess R: Teaching professionalism. CORR 2006;449:177–185.

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Introduction

Robert D. Smink, Jr. MD *and Douglas S. Smink* MD, MPH

This section on the conduct of specific operations is designed with the third-year medical student in mind. Not an atlas of technique or a "cookbook," it is rather a guide to help students prepare for participation in the various procedures and orient themselves to perioperative care by anticipating potential complications.

This Operations section utilizes the six competencies as defined by the ACGME as its organizing principle. Each operative procedure is explained in terms of "Indications" (**Medical Knowledge** and **Patient Care**), "Major Steps" (**Patient Care**), "Complications" (**Practice-Based Learning and Improvement**), "You Need to Know" (**Medical Knowledge**), "Issues for Discussion" (**Communication** and **Professionalism**), and "CPT Codes and Reimbursement" (**Systems-Based Practice**). Struggling with the confines of space, we chose for inclusion the common operations that medical students are likely to encounter during surgical clerkship. As a result, operations that were common decades ago but are uncommonly performed today, such as vagotomy and antrectomy, were not included. The inclusion of a large number of minimally invasive procedures reflects both the training of the younger editor as well as the evolution of the art of surgery to a less invasive approach. We hope that as you spend time on your surgery rotations, you will find that, despite evolution in the surgical craft, one theme in surgery remains unchanged: the surgeon's dedication to patient care.

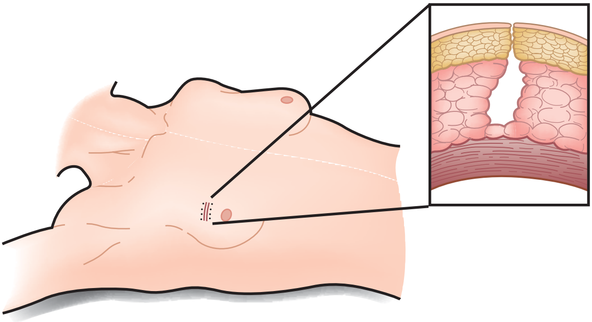
GENERAL COMPLICATIONS TO BE CONSIDERED IN ALL POSTOPERATIVE PATIENTS

Regardless of the operation or the skill of the surgeon, all surgical procedures have potential complications. Some are specific to individual procedures and will be discussed in the context of the specific operations. The complications in Table 1, however, can occur with any procedure. For the sake of standardization, we have listed these general complications in a table format similar to the format used for the specific operations that follow. The inference to be drawn is that these complications should be anticipated and that by following the recommendations made, you will be doing your best to avoid them.

Table 1 Anticipating Potential Complications

• Infection	→ Sterile technique, appropriate use of prophylactic antibiotics
• Bleeding	→ Meticulous hemostasis
• Cardiac complications	→ Preoperative evaluation, intraoperative monitoring, beta-blockade
• Pneumonia, atelectasis	→ Early ambulation, encourage coughing, adequate pain control
• Venous thrombosis, pulmonary emboli	→ Early ambulation, compression devices, subcutaneous heparin in high-risk patients
• Urinary infection, retention	→ Early ambulation, avoid over-distention, early removal of urinary catheter

Operation 1: Breast Biopsy



Breast biopsy. The skin is closed and deeper tissue is allowed to fill with serous fluid

Indications

- Palpable breast mass, undiagnosed
- Abnormal breast imaging
- Benign tumor
- Nipple discharge

Medical Knowledge—You Need to Know

- Mammographic indications for biopsy
- Suspicious characteristics of calcifications on mammography

Major Steps

1. Orientation of incision
2. Wide excision in cases of malignancy

Anticipating Potential Complications

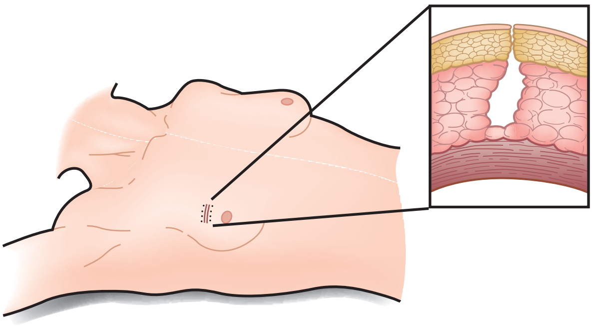
- Hematoma → Meticulous hemostasis
- Cosmetic distortion → Planning incision and extent of excision

Issues for Discussion

- How do we use stereotactic biopsy in the management of imaging abnormalities?

Breast biopsy	Dx 611.72	CPT code 19120	\$250–450
	Dx 793.80	CPT code 19125	\$250–450

Operation 2: Partial Mastectomy (Lumpectomy)



Partial mastectomy is the same concept as breast biopsy, but with attention to proper surgical margins. For invasive cancers, sentinel node biopsy (see Operation 3) commonly accompanies partial mastectomy

Indications

- Invasive breast cancer
- Ductal carcinoma in situ (DCIS)

Medical Knowledge—You Need to Know

- Contraindications to breast preservation
- Staging of breast cancer
- Van Nuys criteria (DCIS)

Major Steps

1. Plan incision to enable resection with acceptable cosmesis
2. Resect lesion with adequate gross margins
3. Orient for pathologist
4. Closure of incision

Anticipating Potential Complications

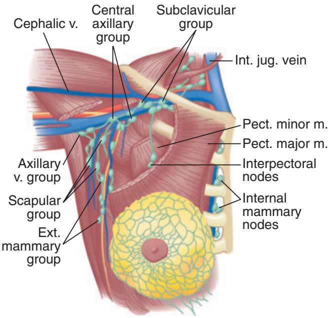
• Hematoma	→ Meticulous hemostasis
• Insufficient margins	→ Gross and pathological examination of tissue removed

Issues for Discussion

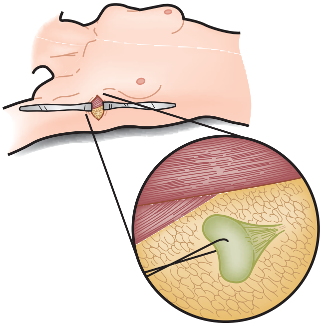
- What is an acceptable margin for resection of invasive cancer?

Partial mastectomy	Dx 174.9 and 233.0	CPT code 19301	$300–525

Operation 3: Sentinel Lymph Node Biopsy (SLNB)



Breast and axillary contents



Sentinel lymph node biopsy; "blue node" identified

Indications

- Invasive breast cancer with clinically negative axilla
- Planned mastectomy for ductal carcinoma in situ

Medical Knowledge—You Need to Know

- Theory of sentinel lymph node
- Lymphatic drainage of breast

Major Steps

1. Injections of radioactive colloid and blue dye
2. Identification of "hot spot"
3. Planning of incision over "hot spot"
4. Identification of sentinel node ("hot" or blue node)
5. Pathologic examination of node—axillary dissection if sentinel node is positive for malignancy

Anticipating Potential Complications

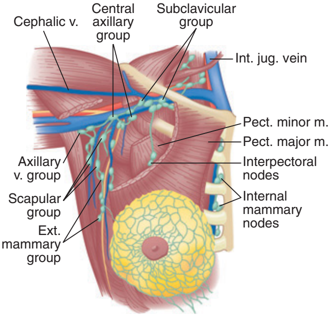
- Blue dye allergy → Use radioactive colloid only
- Seroma → Ligate large lymphatics

Issues for Discussion

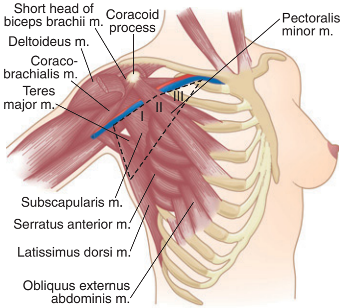
- Compare SLNB and axillary dissection with regard to (1) advantages and (2) false negative rate.
- Why use radioactive colloid, blue dye, or both?
- Where should injections be made in the breast?

Sentinel lymph node biopsy Dx 174.9 CPT code 38525 $200–450

Operation 4: Axillary Node Dissection



Breast and axillary contents



Triangle marks borders of axillary dissection with levels of axillary nodes

Indications

Breast cancer with positive sentinel node or clinically positive nodes in axilla

Medical Knowledge—You Need to Know

- Function of long thoracic, thoracodorsal, and intercostal brachial nerves
- Level I, II, III axillary nodes
- Boundaries of the axilla

Major Steps

1. Incision in skin crease of axilla
2. Identification of axillary vein
3. Identification of long thoracic, thoracodorsal, medial pectoral, and intercostal brachial nerves
4. Identification of pectoralis major and minor and lat. dorsi muscles
5. Resection of axillary levels I and II with appropriate nerve sparing

Anticipating Potential Complications

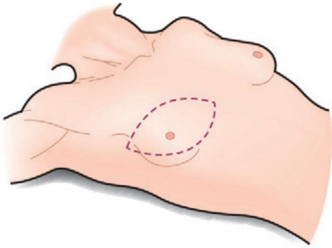
- Seroma → Closed suction drainage
- Frozen shoulder → Postoperative physical therapy
- Winged scapula → Avoid long thoracic nerve injury
- Lymphedema (late) → Known complication

Issues for Discussion

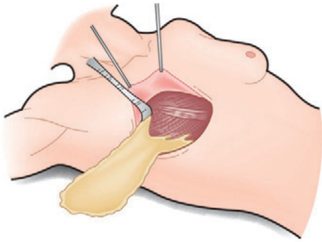
- Why not remove level III nodes?
- Why consider preserving the intercostal brachial nerve?

Axillary dissection	Dx 174.9	CPT code 38745	$720–840

Operation 5: Total (Simple) Mastectomy



Skin incision



Removal of breast, medial to lateral

Indications

- Breast carcinoma—invasive or DCIS
- Prophylactic (in high-risk patients)

Medical Knowledge—You Need to Know

- Different types of invasive cancer
- Staging of breast cancer
- Indications for prophylactic mastectomy
- Anatomic boundaries of dissection for mastectomy

Major Steps

1. Incision incorporating nipple-areolar complex
2. Develop superior and inferior flaps
3. Identify clavicle, sternum, latissimus dorsi, and rectus abdominus
4. Removal of breast with anterior fascia of pectoralis major muscle

Anticipating Potential Complications

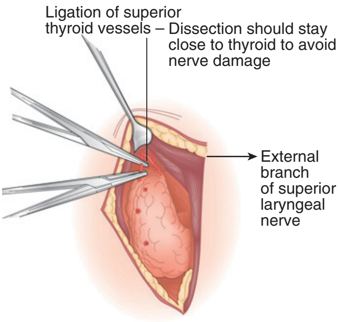
- Seroma → Closed suction drainage
- Flap necrosis → Avoid tension and thin skin flaps

Issues for Discussion

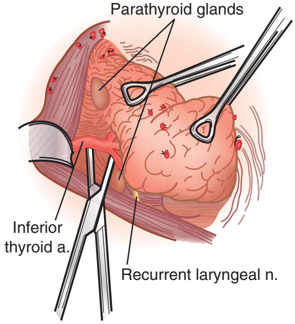
- Can breast cancer develop after prophylactic mastectomy? How?
- What are the indications for adjuvant chemotherapy?
- What are the indications and timing for reconstruction? What procedures are available?

Total, mastectomy Dx 174.9, 233.0 CPT code 19303 $400–800

Operation 6: Thyroidectomy



Division of superior thyroid artery



Division of inferior thyroid artery

Indications

- Solitary nodule (concern for malignancy)
- Hyperthyroidism (e.g., Graves' disease)
- Goiter causing compressive symptoms

Medical Knowledge—You Need to Know

- Vascular supply of the thyroid
- Anatomy of recurrent laryngeal nerve
- Normal and abnormal locations of parathyroids
- Thyroid and parathyroid embryology

Major Steps

1. Collar incision
2. Raise platysma flaps
3. Divide cervical fascia
4. Mobilize strap muscles
5. Divide middle thyroid vein
6. Divide superior thyroid vessels
7. Identify recurrent nerve, parathyroids
8. Divide inferior thyroid vessels
9. Remove gland from trachea
10. Divide isthmus

Anticipating Potential Complications

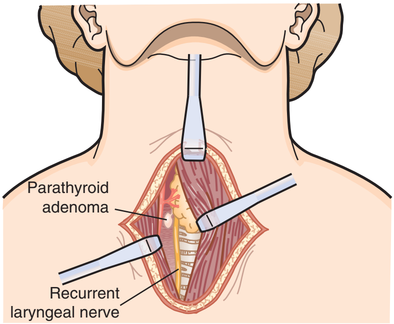
- Hypoparathyroidism ➔ Preserve parathyroids and blood supply
- Recurrent nerve injury ➔ Visualize and protect nerve

Issues for Discussion

- What are the indications for total versus partial thyroidectomy?

Thyroidectomy	Dx 240.9	CPT code 60240	$800–1,100

Operation 7: Parathyroidectomy



Exposure of the parathyroid

Indications

- Primary hyperparathyroidism—adenoma, hyperplasia
- Tertiary hyperparathyroidism

Medical Knowledge—You Need to Know

- Normal and ectopic location of parathyroids
- Embryology and blood supply
- Causes of primary, secondary, and tertiary hyperparathyroidism

Major Steps

1. See Operation 6 for exposure
2. Identify abnormal parathyroids and remove
3. If adenoma, document removal; if hyperplasia, perform total parathyroidectomy with implantation or $3^1/_2$ gland resection

Anticipating Potential Complications

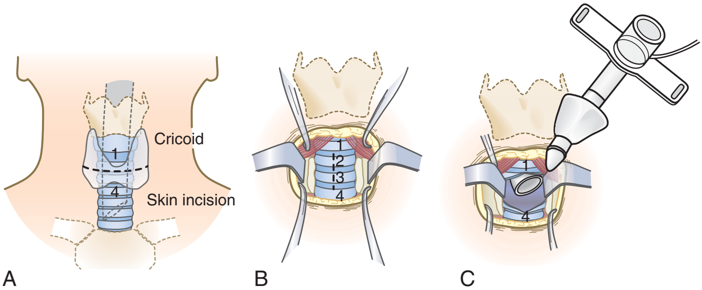
- Recurrent laryngeal nerve injury → Identify and protect nerve
- Recurrent hyperparathyroidism → Remove all abnormal glands
- Hypocalcemia → Check serum calcium postop

Issues for Discussion

- What imaging procedures can localize an adenoma?
- What are the advantages/disadvantages of total parathyroidectomy with implantation versus $3^1/_2$ gland resection?

Parathyroidectomy	Dx 252.00	CPT code 60500	$500–1,100

Operation 8: Tracheostomy



Steps in a tracheostomy

Indications

- Persistent ventilatory insufficiency
- Acute airway obstruction

Medical Knowledge—You Need to Know

- Relationship of thyroid and cricoid cartilage to trachea
- Indications for surgical airway
- Indications for cricothyrotomy

Major Steps

1. Short collar incision
2. Divide anterior cervical fascia
3. Identify trachea and cricoid
4. Retract/divide thyroid isthmus
5. Incise second or third tracheal ring
6. Dilate opening
7. Insert tracheostomy tube
8. Connect to ventilator and secure tube

Anticipating Potential Complications

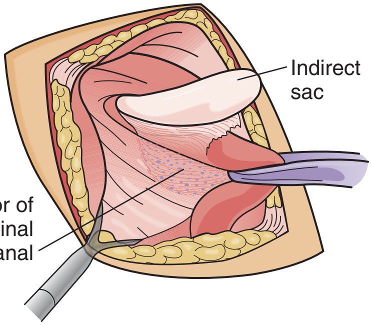
- Loss of airway → Communication with anesthesiologist
- Tracheo-innominate fistula → Place tracheostomy in upper trachea
- Tracheal stenosis (late) → Avoid first tracheal ring

Issues for Discussion

- Does a tracheostomy accelerate weaning from ventilator?
- Should the tracheal incision be horizontal or vertical?

Tracheostomy	Dx 518.82, 786.05	CPT code 31600	$90–250

Operation 9: Open Inguinal Hernia Repair



Note the *indirect* sac in the anteromedial portion of the cord lateral to deep epigastrics (not seen in figure). A *direct* hernia is a weakness in the inguinal floor medial to deep epigastrics.

Indications

- Elective: presence of a hernia in a healthy patient
- Emergent: symptoms of strangulation or incarceration

Medical Knowledge—You Need to Know

- Difference between direct and indirect inguinal hernias
- Muscle layers of anterior abdominal wall
- Location and function of iliohypogastric, ilio-inguinal, and genitofemoral nerves
- Contents of spermatic cord and blood supply of testis

Major Steps

1. Divide external oblique aponeurosis and mobilize spermatic cord
2. If indirect hernia present, dissect hernia sac and ligate at internal inguinal ring ("high dissection of the sac")
3. Reconstruct floor of inguinal canal (with or without mesh)
4. Return cord to anatomic position and close external oblique

Anticipating Potential Complications

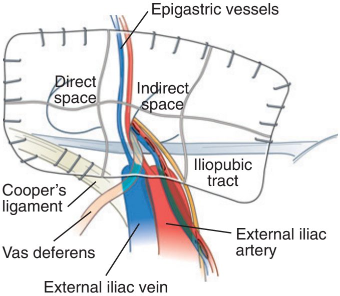
- Recurrence → Identify indirect hernia; careful reconstruction of inguinal floor
- Chronic pain → Avoid injury to peripheral nerves and pubis
- Ischemic orchitis → Isolate and protect spermatic cord

Issues for Discussion

- Is mesh needed for repair of an inguinal hernia?
- What is a sliding hernia and what is its significance?

Inguinal hernia	Dx 550.90	CPT code 49505	$420–600

Operation 10: Laparoscopic Inguinal Hernia Repair



Placement of mesh

Indications

- Bilateral inguinal hernias
- Recurrent inguinal hernia
- Selected unilateral inguinal hernia

Medical Knowledge—You Need to Know

- Anatomy of umbilical ligaments, rectus sheath
- Location of direct, indirect, and femoral hernias
- Anatomy of preperitoneal view of inguinal region

Major Steps

1. Incision at umbilicus, develop space between rectus abdominus and posterior rectus sheath
2. Insufflate preperitoneal space
3. Identify Cooper's ligament
4. Separate hernia sac from spermatic cord
5. Reduce hernia sac from internal inguinal ring (if indirect hernia)
6. Position mesh

Anticipating Potential Complications

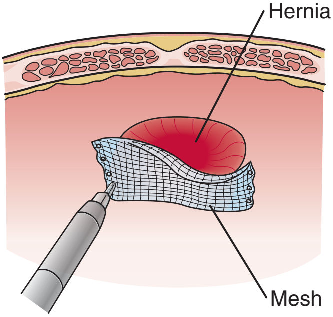
- Iliac vessel injury → Avoid deep dissection
- Recurrence of hernia → Mobilize peritoneum, place adequate size mesh
- Bladder injury → Patient voids preop or place Foley

Issues for Discussion

- Benefits of open versus laparoscopic procedure
- Transabdominal versus totally extraperitoneal laparoscopic repair

Dx 550.90 and 550.91 CPT codes 49650 and 49651 $350–700

Operation 11: Laparoscopic Ventral Hernia Repair



Mesh positioned laparoscopically over hernia defect in anterior abdominal wall

Indications

- Ventral (incisional) hernia
- Large (>4 cm) umbilical hernia

Medical Knowledge—You Need to Know

- Layers of anterior abdominal wall

Major Steps

1. Insufflation of abdomen
2. Lysis of adhesions to anterior abdominal wall
3. Identification of hernia defects
4. Measurement of mesh allowing for overlap of 3 to 4 cm on all sides
5. Placement and securing of mesh

Anticipating Potential Complications

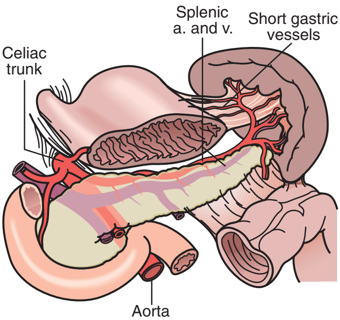
- Bowel injury → Avoid electrocautery during adhesiolysis; carefully inspect bowel
- Recurrence of hernia → Adequate overlap of mesh; place transfascial sutures every 3 to 4 cm

Issues for Discussion

- Veress needle versus Hassan technique to enter abdomen
- Benefits of laparoscopic procedure

Laparoscopic ventral hernia	Dx 553.20 and 553.21	CPT code 49659	$675–725

Operation 12: Splenectomy



Vasculature of the spleen

Indications

- Splenic injury
- Hematologic indications
  - Spherocytosis
  - Idiopathic thrombocytopenic purpura (ITP)
  - Symptomatic splenomegaly

Medical Knowledge—You Need to Know

- Vascular supply and ligamentous attachments of spleen
- Hematologic indications for splenectomy
- Causes and risks of overwhelming postsplenectomy sepsis (OPSS)

Major Steps

1. Upper midline or left subcostal incision (note: splenectomy can also be done laparoscopically)
2. Ligate splenic artery in lesser sac (elective cases only)
3. Mobilize attachments—diaphragm, renal, colic, short gastric vessels
4. Ligate or staple vessels at splenic hilum

Anticipating Potential Complications

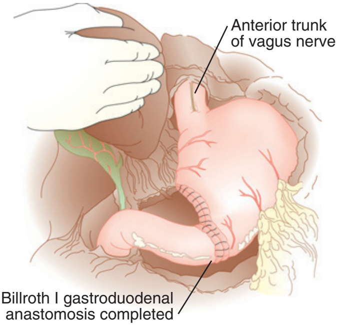
- Hemorrhage → Careful handling of spleen and identification of splenic artery and short gastric vessels
- Pancreatic fistula → Identification and protection of pancreatic tail
- OPSS → Vaccination against encapsulated organisms; educate patient about symptoms and need for early treatment
- Gastric injury → Careful ligation of short gastric vessels

Issues for Discussion

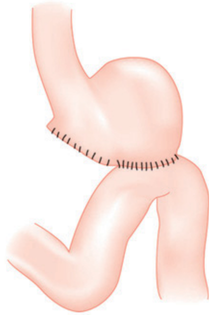
- What are advantages of splenic salvage in trauma?
- When, relative to operation, should patients be vaccinated?

Splenectomy	Dx 287.01	CPT code 38100	$400–750

Operation 13: Gastrectomy



Partial gastrectomy with Billroth I (gastroduodenostomy)



Partial gastrectomy with Billroth II (gastrojejunostomy)

Indications

- Gastric cancer
- Intractable bleeding stress ulcers
- Peptic ulcer disease—bleeding, perforation, obstruction, intractability

Medical Knowledge—You Need to Know

- Anatomy of stomach and blood supply duodenum
- Anatomy of vagus nerves
- Staging of gastric cancer
- Methods of reconstruction: Billroth I and II, Roux-en-Y

Major Steps

1. Upper midline incision
2. Determine limits of resection
3. Ligate blood vessels
4. Resect stomach
5. Close duodenal stump
6. Reconstruct gastrointestinal tract
7. Perform vagotomy (peptic ulcer disease)

Anticipating Potential Complications

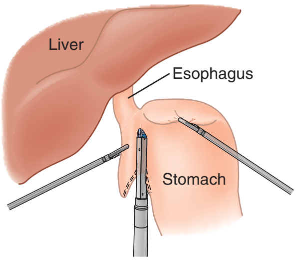
- Duodenal stump leak → Careful closure of duodenum
- Recurrent ulcer → Adequate vagotomy and antral resection
- Bile reflux gastritis → Roux-en-Y anastomosis
- Anemia (late) → Iron and vitamin B_{12} supplementation

Issues for Discussion

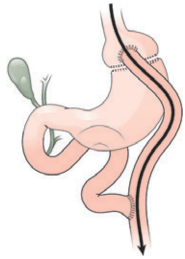
- How do antrectomy and vagotomy decrease acid production?
- What are the different types of vagotomy?

Gastrectomy	Dx 151.9	CPT code 43632	$1,800–2,000

Operation 14: Laparoscopic Gastric Bypass



Creation of 30-mL gastric pouch



Completed Roux-en-Y gastric bypass

Indications

- Morbid obesity
  - BMI > 40
  - BMI > 35 with obesity-related comorbidities (diabetes, hypertension, hyperlipidemia, sleep apnea, etc.)

Medical Knowledge—You Need to Know

- Anatomy of Roux-en-Y
- Comorbidities of obesity
- Vitamin deficiencies after gastric bypass

Major Steps

1. Identification of ligament of Treitz
2. Division of jejunum 50 cm distal to ligament of Treitz
3. Jejuno-jejunostomy 75 to 150 cm distal to division of jejunum
4. Creation of gastric pouch
5. Creation of gastrojejunostomy (stomach to Roux limb)

Anticipating Potential Complications

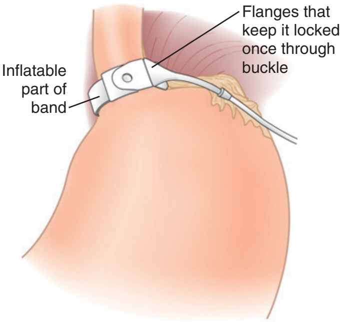
- Anastomotic leak → Intraoperative leak test (endoscopy, air insufflation, and/or methylene blue) and/or postoperative barium swallow
- Vitamin deficiencies → Vitamin supplementation
- Deep venous thrombosis → Prophylactic anticoagulation, early ambulation

Issues for Discussion

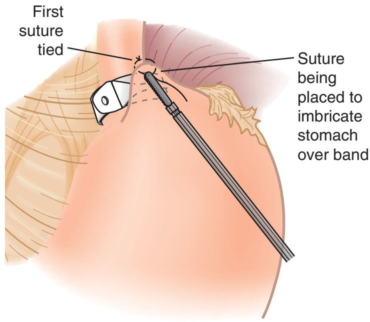
Comparison of laparoscopic and open gastric bypass

Gastric bypass	Dx 278.01	CPT code 43846	$1,400

Operation 15: Laparoscopic Adjustable Gastric Band



Gastric band in place



Completed positioning of gastric band

Indications

- Morbid obesity
  - BMI > 40
  - BMI > 35 with obesity-related comorbidities (diabetes, hypertension, hyperlipidemia, sleep apnea, etc.)

Medical Knowledge—You Need to Know

- Anatomy of proximal stomach, GE junction, crura

Major Steps

1. Division of peritoneum at angle of His
2. Opening in gastrohepatic ligament
3. Passage of instrument posterior to stomach
4. Placement and fixation of band
5. Fixation of port to anterior abdominal wall fascia

Anticipating Potential Complications

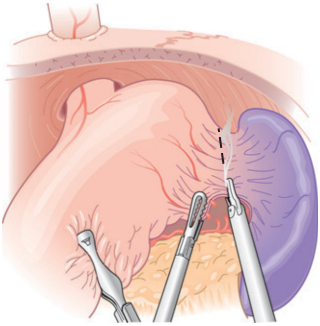
• Injury to great vessels or posterior stomach	→ Careful dissection posterior to stomach
• Band slippage	→ Imbricate stomach over band

Issues for Discussion

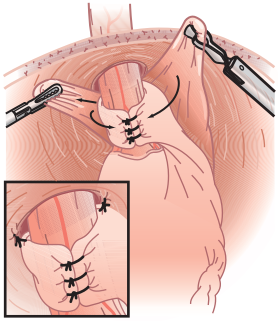
- What are the benefits of gastric banding versus gastric bypass?

Lap gastric band	Dx 278.01	CPT code 43770	$940–1,200

Operation 16: Laparoscopic Fundoplication



Division of short gastric vessels



Creation of Nissen fundoplication

Indications

- Symptomatic gastroesophageal reflux
- Paraesophageal hernia, types 2 or 3

Medical Knowledge—You Need to Know

- Blood supply to stomach
- Types of paraesophageal hernia
- Workup of a patient with gastroesophageal reflux disease (upper endoscopy, pH monitor, esophageal manometry)
- Risks for Barrett's esophagus
- Types of fundoplication

Major Steps

1. Dissection of diaphragmatic crura
2. Identification of vagus nerves
3. Reduction of hernia sac (if paraesophageal hernia present)
4. Division of short gastric vessels
5. Closure of diaphragmatic hiatus
6. Creation of fundoplication

Anticipating Potential Complications

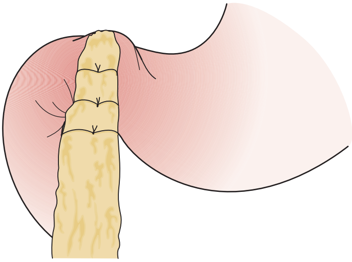
- Esophageal leak → Dissect crura, not esophagus
- Slipped Nissen → Suture wrap to distal esophagus
- Recurrent hiatal hernia → Placement of mesh (controversial)

Issues for Discussion

- Screening and treatment of a patient with Barrett's esophagus.

Lap fundoplication	Dx 553.3, 530.87	CPT: 43280	$920–1,250

Operation 17: Graham Patch for Perforated Ulcer



Graham patch: omentum over closure of perforated ulcer

Indications

- Perforated duodenal ulcer

Medical Knowledge—You Need to Know

- Risk factors for peptic ulcer disease
- Anatomy and blood supply of duodenum
- Recognition that the first portion of the duodenum is intraperitoneal, explaining why anterior duodenal ulcers may present with free perforation
- Physiology of acid production and surgical methods of acid reduction
- A perforated *gastric* ulcer requires biopsy due to the possibility of underlying malignancy

Major Steps

1. Upper midline incision
2. Oversew perforation and protect with omental patch
3. Copious peritoneal lavage with saline

Anticipating Potential Complications

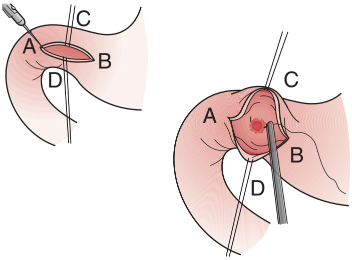
- Abdominal abscess → Copious irrigation, antibiotics
- Gastric outlet obstruction → Avoid narrowing of duodenum
- Recurrent perforation → Eradicate *Helicobacter pylori*, minimize acid production

Issues for Discussion

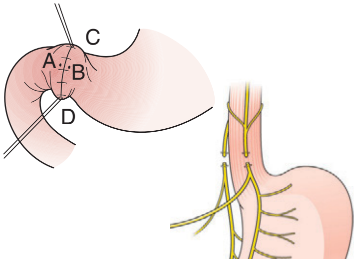
- When is definitive ulcer surgery indicated in perforated ulcers?
- What are the differences in management between gastric and duodenal ulcers?

Gastrorrhaphy oversew Dx 531.0 CPT code 43840 $750–1,100

Operation 18: Oversew of Bleeding Duodenal Ulcer (Vagotomy and Pyloroplasty)



Oversewing a posterior duodenal ulcer



Transverse closure of duodenum truncal vagotomy

Indications

- Bleeding duodenal ulcer

Medical Knowledge—You Need to Know

- Risk factors for peptic ulcer disease
- Anatomy and blood supply of duodenum
- Recognition of position of gastroduodenal artery, explaining why posterior duodenal ulcers present with bleeding
- Physiology of acid production; surgical methods of acid reduction
- Endoscopic and interventional methods to control bleeding

Major Steps

1. Upper midline incision
2. Longitudinal incision over pylorus, oversew ulcer with deep sutures and close duodenum transversely (pyloroplasty)
3. Consider truncal vagotomy

Anticipating Potential Complications

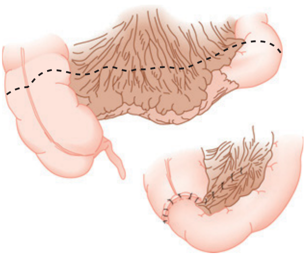
- Gastric outlet obstruction → Avoid narrowing of duodenum
- Recurrent bleeding → Eradicate *Helicobacter pylori*, minimize acid production

Issues for Discussion

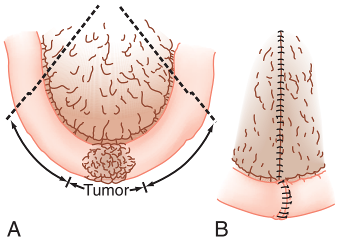
- Indications for operation in a patient with a bleeding ulcer.
- When is acid-reducing surgery indicated in bleeding ulcers?
- What are the postvagotomy syndromes?

Vagotomy and pyloroplasty   Dx 532.00   CPT code 43640 $1250

Operation 19: Small Bowel Resection



Ileocecal resection



Small bowel resection

Indications

- Crohn's disease
- Ischemic bowel
- Small bowel tumor
- Damaged bowel during lysis of adhesions

Medical Knowledge—You Need to Know

- Blood supply to small bowel
- Criteria to assess bowel viability

Major Steps

1. Determine proximal and distal limits of resection
2. Divide bowel
3. Divide mesentery
4. Perform anastomosis
5. Close mesenteric defect

Anticipating Potential Complications

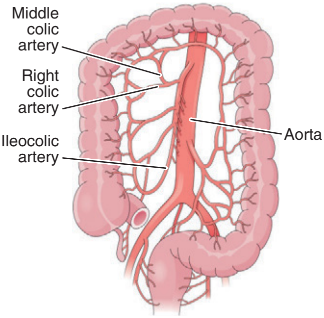
• Infection	→ Avoid spillage of enteric contents
• Anastomotic dehiscence	→ Well-vascularized anastomosis without tension
• Paralytic ileus/obstruction	→ Minimize handling of bowel

Issues for Discussion

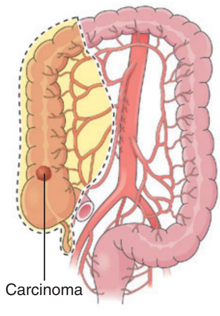
- What are the advantages of various methods of anastomosis?
  - Stapled versus sutured
  - One layer versus two layers

Small bowel resection   Dx 555.0   CPT code 44120 $700–1,200

Operation 20: Right Colectomy



Vascular supply of right colon



Resection for right colectomy

Indications

- Cancer of right colon
- Crohn's disease
- Sessile polyps
- Bleeding AVMs

Medical Knowledge—You Need to Know

- Blood supply of right colon
- Anatomy of the ileocecal valve
- Various methods of anastomosis

Major Steps

1. Lower midline or right transverse incision
2. Mobilize right colon and protect ureter, vena cava, and duodenum
3. Ligate ileocolic, right colic arteries
4. Resect distal 8 to 10 cm of ileum to midtransverse colon
5. Anastomose bowel and close mesenteric defect

Anticipating Potential Complications

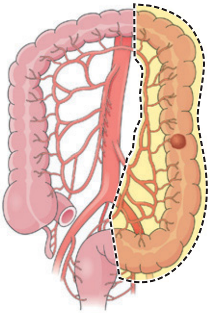
- Ureteral injury → Identify and protect ureter
- Anastomotic leak → Well-vascularized anastomosis without tension
- Wound infection → Preoperative antibiotics, avoid spillage of stool

Issues for Discussion

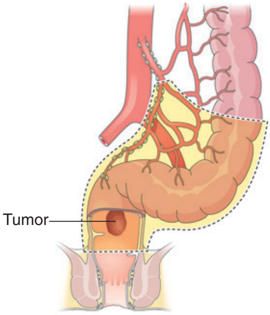
- How can you correct for marked differences in the lumen size of the bowel ends to be anastomosed?

Right colectomy	Dx 153.6	CPT code 44160	$920–1,600

Operation 21: Left Colectomy and Low Anterior Resection



Left colectomy resection



Low anterior resection (removal of sigmoid colon and upper rectum)

Indications

- Carcinoma of colon or rectum
- Diverticulitis of sigmoid
- Miscellaneous pathology of left colon

Medical Knowledge—You Need to Know

- Blood supply of colon and rectum
- Lymphovascular drainage
- Anatomy of the ureters
- Surgical indications, for diverticulitis

Major Steps

1. Midline incision
2. Mobilize splenic flexure
3. Mobilize left colon
4. Protect ureter
5. Mobilize rectum
6. Ligate inferior mesenteric artery
7. Resect colon
8. Perform anastomosis

Anticipating Potential Complications

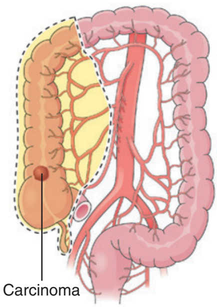
- Ureteral injury → Identify and protect ureter
- Anastomotic leak → Well-vascularized anastomosis without tension
- Pelvic abscess → Bowel prep, avoid spillage of stool

Issues for Discussion

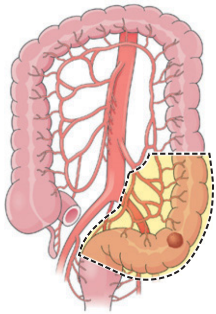
- What is the importance of "bowel prep" in colon surgery?
- What is the "watershed" area of left colon?

Left colectomy	Dx 153.9 and 154.1	CPT codes 44140 and 44146	$1,000–2,000

Operation 22: Laparoscopic Colectomy



Right colectomy resection



Sigmoid colectomy resection

Indications

- Diverticulitis
- Colon polyps
- Colon cancer

Medical Knowledge—You Need to Know

- Vascular supply of the colon
- Anatomy of the ureters

Major Steps

1. Insufflation of the abdomen
2. Inspection of the liver
3. Mobilization of colon to be resected
4. Division of mesentery and blood vessels
5. Division of colon
6. Creation of anastomosis
7. Removal of specimen

Anticipating Potential Complications

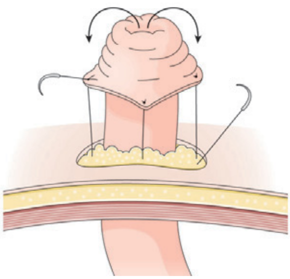
- Bowel injury → Avoid electrocautery during adhesiolysis
- Anastomotic leak → Avoid tissue ischemia, tension

Issues for Discussion

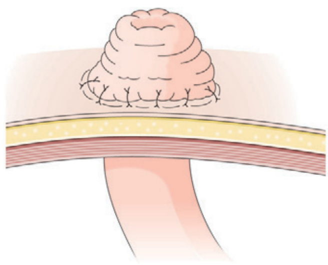
- Comparison of laparoscopic and open procedures, particularly wound complications and tumor recurrence

Laparoscopic colectomy	Dx 562.11, 211.3, or 153.9	CPT code 44204, 44205 or 44207	$1,000–1,500

Operation 23: Colostomy and Ileostomy



Placement of sutures in Brooke ostomy



Completed Brooke ostomy

Indications

- Temporary need for diversion of enteric content
- Permanent need due to absence or exclusion of anorectum

Medical Knowledge—You Need to Know

- Types of ostomies (loop, end, double-barrel)

Major Steps

- Loop
  1. Exteriorize loop of bowel
  2. Place rod through mesenteric opening
  3. Fix rod to skin surface
  4. Open anterior wall of bowel
- End (Brooke)
  1. Mobilize bowel to exteriorize
  2. "Mature" stoma (see figure above)

Anticipating Potential Complications

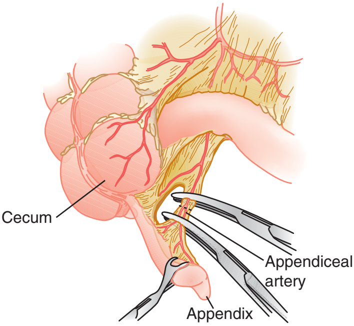
- Necrosis → Minimize tension, maintain blood supply
- Retraction → Exteriorize bowel without tension
- Peristomal dermatitis → Create everted stoma, proper pouching
- Parastomal hernia → Place stoma through rectus muscle

Issues for discussion

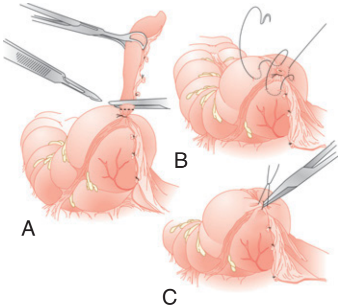
- How do you determine the location of the stoma on the skin?

Stoma creation Dx V55.2, V55.4 CPT codes 44310, 44320 $850

Operation 24: Open Appendectomy



Ligation of appendiceal artery



Division and inversion of appendiceal base

Indications

- Clinical history or CT scan compatible with acute appendicitis

Medical Knowledge—You Need to Know

- Anatomy of abdominal wall muscles
- Blood supply of appendix
- Pathophysiology of appendicitis
- Location of McBurney's point
- Symptoms associated with progression of disease

Major Steps

1. Muscle splitting incision over McBurney's point
2. Mobilize cecum and appendix
3. Ligate base of appendix and mesoappendix
4. Invert base of appendix

Anticipating Potential Complications

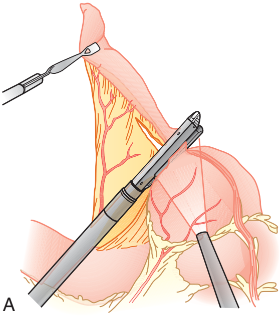
- Intra-abdominal abscess → Antibiotics, drain fluid accumulation
- Cecal fistula → Secure closure of appendiceal stump

Issues for Discussion

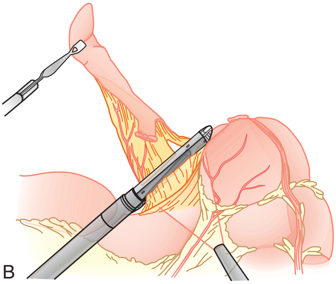
- Would you close the skin incision in perforated appendicitis?

Appendectomy	Dx 540.9	CPT code 44950	$540–875

Operation 25: Laparoscopic Appendectomy



Division of base of appendix



Division of mesoappendix

Indications

- Same as open appendectomy
- Particularly useful in females, those with uncertain diagnosis, obese patients

Medical Knowledge—You Need to Know

- Anatomy of appendix, cecum, and appendiceal artery
- Contraindications to laparoscopy

Major Steps

1. Umbilical incision: create pneumoperitoneum and place 10-mm port
2. Place two other ports, one suprapubic and one other
3. Dissection of base of appendix
4. Division of appendiceal base
5. Division of mesoappendix
6. Remove specimen

Anticipating Potential Complications

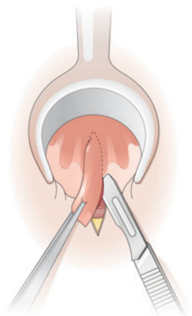
- Wound infection → Removal of appendix in specimen bag
- Abscess → Careful handling of appendix; irrigation

Issues for Discussion

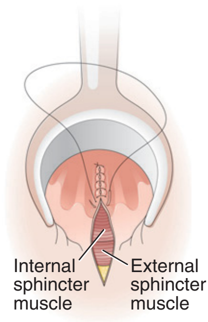
- What are the advantages of laparoscopic vs. open appendectomy?

Laparoscopic appendectomy   Dx 540.9   CPT code 44970 $450–600

Operation 26: Hemorrhoidectomy



Excision of hemorrhoid



Closure of internal defect

Indications

- Symptomatic third- or fourth-degree hemorrhoids

Medical Knowledge—You Need to Know

- Difference between external and internal hemorrhoids
- Classification of degree of hemorrhoids
- Vascular anatomy and innervation

Major Steps

1. Prone or lithotomy position
2. Dilate anal canal manually
3. Identify primary hemorrhoidal columns
4. Excise each column
5. Close internal defect to anal verge
6. Leave external component open

Anticipating Potential Complications

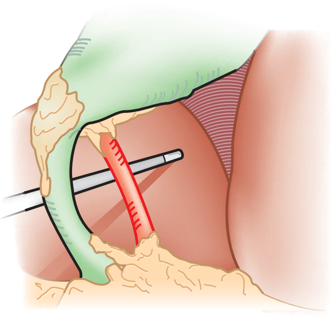
- Bleeding → Meticulous hemostasis
- Stricture → Avoid excess removal of anal skin
- Fecal impaction → Stool softeners and laxatives postoperatively

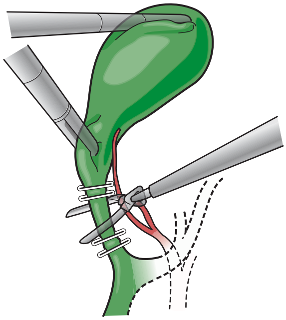
Issues for Discussion

- How are hemorrhoids managed in patients with portal hypertension?
- How are thrombosed external hemorrhoids managed?
- How are bleeding internal hemorrhoids managed?

Hemorrhoidectomy	Dx 455.0–8	CPT code 46260	$375–575

Operation 27: Laparoscopic Cholecystectomy


Complete dissection of triangle of Calot


Transection of cystic duct between clips

Indications

- Biliary colic
- Acute and chronic cholecystitis

Medical Knowledge—You Need to Know

- Difference between biliary colic and acute cholecystitis
- Anatomy of triangle of Calot with common variations

Major Steps

1. Retraction of gallbladder laterally and superiorly to open triangle of Calot
2. Dissection and clear identification of cystic duct and cystic artery
3. Division of cystic duct and cystic artery
4. Dissection of gallbladder from liver bed (retrograde dissection)
5. Removal of gallbladder through umbilical or epigastric port

Anticipating Potential Complications

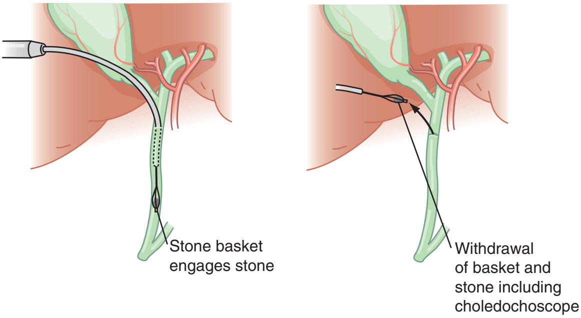
- Bile leak → Careful closure of cystic duct stump
- Injury to common bile duct → Careful assessment of anatomy; perform cholangiography when in doubt

Issues for Discussion

- When does one convert a lap cholecystectomy to an open procedure?

Lap cholecystectomy	Dx 574.20	CPT code 47562	$500–700

Operation 28: Common Bile Duct Exploration



Removal of a common duct stone using choledochoscope and basket

Indications

- Common duct stones
- Undiagnosed common duct obstruction

Medical Knowledge—You Need to Know

- Anatomy of extrahepatic biliary system
- Relationship of common duct to duodenum and head of pancreas

Major Steps

1. Identify common bile duct; can follow gallbladder and cystic duct if present, otherwise dissect from lateral to duct
2. Perform "Kocher maneuver" (mobilize duodenum and head of pancreas)
3. Place "traction sutures" and open duct (usually longitudinally)
4. Perform maneuvers for stone extraction—suction, irrigation, choledochoscopy, balloon catheter
5. Close choledochotomy over T-tube
6. Perform cholangiography to verify stone extraction

Anticipating Potential Complications

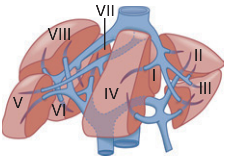
- Pancreatitis → Minimize manipulation of ampulla
- Retained stones → Choledochoscopy, completion cholangiography
- Duct stricture → Avoid narrowing duct with closure

Issues for Discussion

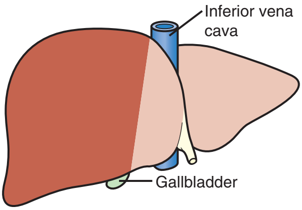
- How is the T-tube managed?
- How are retained stones managed?

Common bile duct	Dx 574.30	CPT code 47420	$1,200–1,600
exploration	Dx 574.30	CPT code 47610	$1,000–1,200

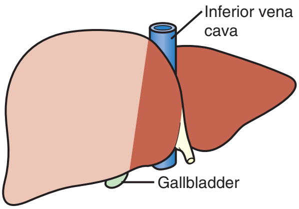
Operations 29: Hepatic Lobectomy



Anatomic segments of the liver



Right hepatic lobectomy (segments V–VIII)



Left hepatic lobectomy (segments II–IV)

Indications

- Colorectal metastasis with three or fewer lesions
- Primary liver tumor

Medical Knowledge—You Need to Know

- Ligamentous anatomy of the liver
- Anatomic liver segments
- Arterial and venous anatomy of the liver, including portal vein

Major Steps

1. Bilateral subcostal incision with superior extension, or midline
2. Abdominal exploration to r/o extrahepatic disease
3. Ligate affected hepatic artery, duct, and portal vein
4. Parenchymal dissection on line of demarcation
5. Ligate or staple affected hepatic vein

Anticipating Potential Complications

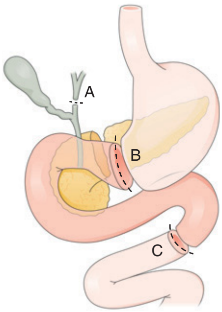
- Subhepatic abscess → Closed suction drainage
- Biliary fistula → Prolonged closed-suction drainage

Issues for Discussion

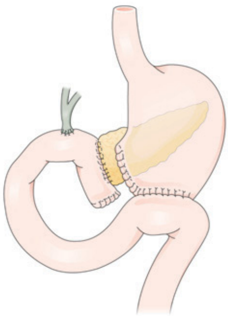
- Why is intraoperative ultrasonography useful during liver surgery?

Hepactic lobectomy	Dx 197.7 and 155.2	CPT code 47120	$1,600–2,000

Operation 30: Whipple Procedure (Pancreaticoduodenectomy)



Resection of Whipple procedure



Completion of procedure showing pancreaticojejunostomy, choledochojejunostomy, and gastrojejunostomy

Indications

- Confirmed carcinoma of pancreatic head, duodenum, or ampulla
- High suspicion for pancreatic carcinoma

Medical Knowledge—You Need to Know

- Vascular anatomy surrounding pancreatic head
- Workup for a patient with painless jaundice

Major Steps

1. Bilateral subcostal or upper midline incision
2. Confirm resectability (no extrahepatic disease or major vascular invasion)
3. Kocher maneuver (mobilize duodenum and pancreatic head)
4. Divide common bile duct
5. Create plane anterior to portal vein and superior mesenteric vein
6. Divide distal stomach
7. Divide jejunum distal to ligament of Treitz
8. Divide pancreas just anterior to portal vein
9. Ligate venous branches to superior mesenteric vein
10. Skeletonize hepatic artery
11. Reconstruct anatomy:
    - Hepaticojejunostomy
    - Pancreaticojejunostomy
    - Gastrojejunostomy

Anticipating Potential Complications

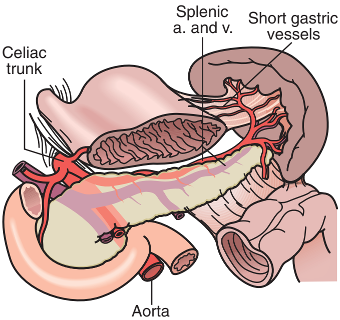
• Hemorrhage	→ Careful dissection around portal and superior mesenteric veins, suture ligation of gastroduodenal artery
• Pancreaticojejunal leak	→ Stent in pancreatic duct, closed suction drain to control leak
• Other anastomotic leaks	→ Well-vascularized anastomosis without tension
• Malnutrition	→ Place feeding jejunostomy tube

Issues for Discussion

- How are unresectable cases of pancreatic cancer managed?
- What is the survival benefit of a Whipple procedure for pancreatic cancer?

Whipple procedure	Dx 157.9	CPT code 48150	$2,000–3,500

Operation 31: Distal Pancreatectomy



Vasculature of the spleen

Indications

- Distal pancreatic tumor—benign or malignant

Medical Knowledge—You Need to Know

- Anatomy and blood supply of pancreas and spleen
- Types of pancreatic tumors

Major Steps

1. Left subcostal or upper midline incision
2. Mobilize spleen (see Operation 12, Splenectomy)
3. Enter retroperitoneum lateral to pancreatic tail
4. Mobilize to level of superior mesenteric artery
5. Ligate splenic artery, then vein
6. Transect pancreas with stapler

Anticipating Potential Complications

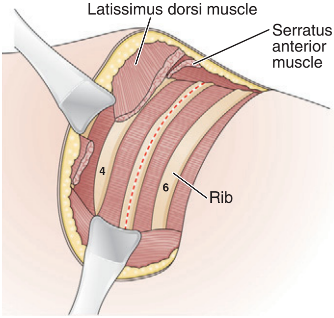
- Hemorrhage → Meticulous hemostasis
- Pancreatic fistula or pseudocyst → Careful closure of pancreatic stump

Issues for Discussion

- Does the spleen need to be removed with a distal pancreatectomy?

Distal pancreatectomy	Dx 157.9	CPT code 48140	$700–1,700

Operation 32: Pulmonary Lobectomy



Posterolateral thoracotomy

Indications

- Primary lung cancer involving one lobe with adequate pulmonary reserve
- Persistent lobar infection refractory to medical therapy

Medical Knowledge—You Need to Know

- Pulmonary arterial and venous anatomy
- Bronchial and lobar anatomy of the lungs

Major Steps

1. Posterolateral thoracotomy
2. Divide inferior pulmonary ligament and divide mediastinal pleura at its reflection
3. Ligate and divide pulmonary artery branch to lobe to be removed
4. Ligate and divide pulmonary venous branch to lobe to be removed
5. Staple and divide bronchus to lobe to be removed
6. Mediastinal lymph node dissection for primary lung cancer
7. Chest tube drainage and closure

Anticipating Potential Complications

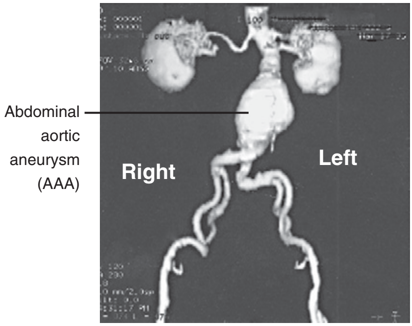
- Pneumonia → Pain control, ambulation, incentive spirometry
- Postoperative arrhythmias → Beta-blockade
- Prolonged air leak → Meticulous closure of bronchus and any parenchymal plane of resection

Issues for Discussion

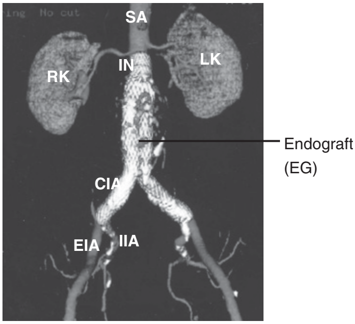
- How would you work up a solitary pulmonary nodule found on routine CXR?

Pulmonary lobectomy	Dx 162.9	CPT code 32480	$1,300–1,800

Operation 33: Endovascular Aneurysm Repair (EVAR)



CT-angiogram showing aorta, kidneys, aneurysm



CT-angiogram showing endograft in neck of AAA and iliacs

Indications

- Infrarenal abdominal aortic aneurysm (AAA) greater than 5.5 cm
- Ruptured AAA

Medical Knowledge—You Need to Know

- Pathogenesis and natural history of AAA
- Branches of the abdominal aorta
- Imaging evaluation of AAA
- Type of endovascular leaks
- Anatomic issues for EVAR

Major Steps

1. Femoral artery exposure
2. Retrograde femoral artery access
3. Aortography with identification of renal arteries
4. Graft deployment
5. Completion angiography

Anticipating Potential Complications

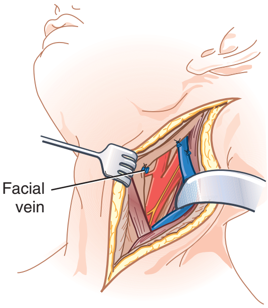
- Proximal type 1 leak → Accurate sizing of proximal neck
- Peripheral embolization → Adequate heparinization and flushing
- Perioperative renal insufficiency → Judicious use of iodinated contrast, volume resuscitation

Issues for Discussion

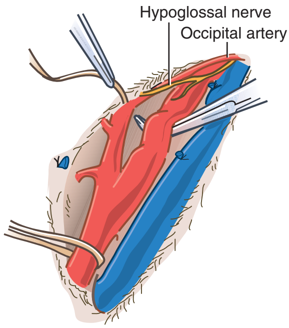
- How are endovascular leaks diagnosed and treated?
- Is EVAR currently the standard of care?
- What are the indications for open AAA repair?

Endovascular aneurysm repair Dx 441.4 CPT code 34802 $2500

Operation 34: Carotid Endarterectomy



Carotid bifurcation exposed after transection of facial vein and retraction of internal jugular vein



Passing tapes above and below disease-bearing carotid segment

Indications

- Symptomatic carotid stenosis with greater than 70% stenosis
  - Transient ischemic attack
  - Hemispheric stroke with recovery
  - Stroke in evolution
- Asymptomatic carotid stenosis with greater than 75% stenosis

Medical Knowledge—You Need to Know

- Radiological evaluation of carotid bifurcation, i.e., ultrasonography, CT angiography, magnetic resonance angiography, conventional angiography
- Anatomy of carotid bifurcation, including neighboring nerves
- Risk of stroke with carotid stenosis
- Long-term results of carotid endarterectomy

Major Steps

1. Oblique incision along medial border of sternocleidomastoid muscle
2. Isolation of common, internal, and external carotid arteries
3. Heparinization prior to cross-clamping
4. Clamping of carotid vessels with determination of cerebral tolerance
5. Arteriotomy, endarterectomy, and closure with patch angioplasty
6. Verification of technical result

Anticipating Potential Complications

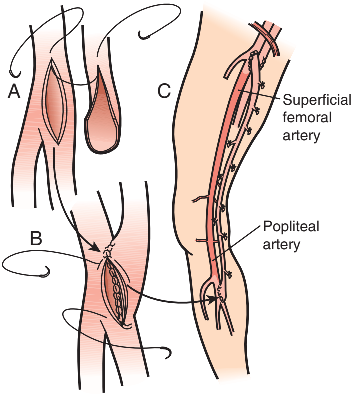
• Vagus nerve injury	→ Identify and protect nerve
• Hypoglossal nerve injury	→ Identify and protect nerve
• Intraoperative emboli	→ Careful dissection technique and carotid clamping and unclamping sequence
• Postoperative thrombosis	→ Careful endarterectomy technique

Issues for Discussion

- Is cervical block or general anesthesia preferable?
- When is intraoperative shunting indicated?
- Is carotid artery stenting preferable to endarterectomy?

Carotid endarterectomy	Dx 433.10	CPT code 35301	$1,100–1,700

Operation 35: Femoral-Popliteal Bypass Grafting



Creation of vascular anastomosis and completed femoral-popliteal bypass

Indications

- Peripheral vascular occlusive disease (PVOD) with gangrene, ischemic ulceration, rest pain
- Claudication with significant stenosis or occlusion of SFA

Medical Knowledge—You Need to Know

- Risk factors for PVOD
- Arterial, muscular, and nerve anatomy of the lower extremity
- Signs of ischemia on exam
- Studies used to evaluate PVOD
- Natural history of claudication

Major Steps

1. Inguinal and medial thigh incisions
2. Isolate common, superficial, and deep femoral arteries
3. Harvest segment of saphenous vein (use PTFE graft if unavailable)
4. Create tunnel between femoral and popliteal arteries
5. Place reversed saphenous vein in tunnel
6. Create proximal and distal anastomoses
7. Verify adequate blood flow through graft

Anticipating Potential Complications

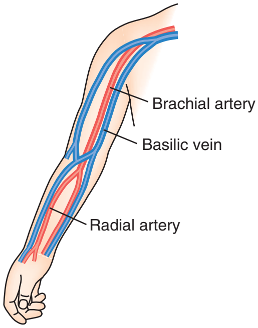
- Peripheral embolization → Adequate heparinization and flushing
- Immediate graft thrombosis → Ascertain adequate inflow and outflow, meticulous suturing technique
- Perioperative MI → Preoperative cardiovascular evaluation

Issues for Discussion

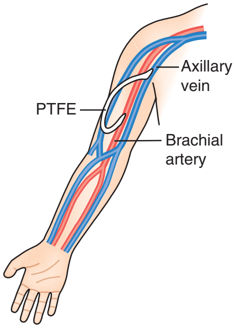
- What are the advantages of vein over prosthetic graft?
- What are expectations for long-term patency?

Fem-pop bypass	Dx 444.22	CPT code 35556	$1,100–1,700

Operation 36: Dialysis Access Procedures



Common sites for arteriovenous fistulae



Loop graft in upper arm

Indications

- Need for hemodialysis

Medical Knowledge—You Need to Know

- Indications for dialysis
- Indications for peritoneal dialysis
- Options for site of fistula

Major Steps

- Radiocephalic fistula
  1. Mobilize radial artery and cephalic vein at wrist
  2. Dilate vein to appropriate size (3 mm)
  3. Create side-to-side or end-to-side anastomosis
- Interposition graft (usually PTFE) between brachial artery at elbow and axillary vein
  1. Mobilize the vessels
  2. Create tunnel subcutaneously between the vessels
  3. Pass graft into tunnel
  4. Create end-to-side anastomoses

Anticipating Potential Complications

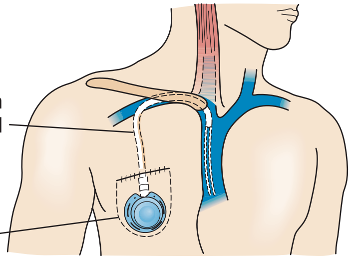
- Thrombosis → Meticulous technique of anastomosis
- Infection (late) → Avoid PTFE when able
- Steal syndrome → Avoid large arterial anastomosis

Issues for Discussion

- What access routes are preferred and why?
- How soon after surgery can a fistula or graft be used?

Dialysis access Dx 585.6 CPT codes 36821, 36830 $500–980

Operation 37: Insertion of Portacath



Vascular access port placed through right subclavian vein

Indications

- Need for ongoing frequent venous access
- Poor peripheral venous access

Medical Knowledge—You Need to Know

- Seldinger technique
- Anatomy of subclavian and internal jugular veins and SVC

Major Steps

1. Percutaneous cannulation of subclavian or internal jugular vein
2. Pass guide wire into superior vena cava (SVC) and document radiographically
3. Create subcutaneous pocket for reservoir in anterior chest wall
4. Place reservoir, and tunnel catheter to guide wire site
5. Pass catheter into SVC with Seldinger technique
6. Ascertain proper location and function
7. Secure reservoir in pocket

Anticipating Potential Complications

- Pneumothorax → Careful puncture of subclavian vein
- Arterial injury → Careful puncture of subclavian vein
- Perforation central vein → Avoid force when inserting dilator
- Thrombosis and infection → Unavoidable in some patients

Issues for Discussion

- How is pneumothorax diagnosed and treated?

Port insertion	Dx 199.1	CPT code 36561	$300–1,400

You are encouraged to review the preoperative, operative, and postoperative course of any patient whose operation you have participated in by using the Competency Self-Assessment Form on page 35, which can also be found as a Word document on the book's Web site at www.studentconsult.com. Give specific thought to what efforts were made to make your patient safe and comfortable in the operating room during the immediate pre-op and post-op periods.

Credits

Text

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Communication behaviors and skills on page 13 and in Table 4-1: From *Successfully Navigating the First Year of Surgical Residency: Essentials for Medical Students and PGY-1 Residents,* p. 20, Division of Education, American College of Surgeons © 2005.

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Physician's Charter principles and commitments: From ABIM Foundation, ACP Foundation, European Federation of Internal Medicine. Medical Professionalism in the New Millennium: A physician charter. *Annals of Internal Medicine,* 2002;136:243–246.

Excerpts from American College of Surgeons' Code of Professional Conduct in Table 5-1: From American College of Surgeons' Code of Professional Conduct, www.facs.org/memberservices/codeofconduct.html, American College of Surgeons © 2003.

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Figures

Figures 10-2, 10-3, 10-4, 10-5, 10-6, 10-7, 10-9, 10-10, 10-17, 48-2 (modified), 48-3, 48-7, 48-12, 48-13: From P. Wiest and R. Roth: *Fundamentals of Emergency Radiology*. WB Saunders, 1996. Copyright Elsevier, 1996.

Figure 10-8: From W. Zwiebel and R. Sohaey: *Introduction to Ultrasound*. Philadelphia, WB Saunders, 1998.

Figures 10-13, 10-15, 10-18, 48-14: From J. Haaga, C. Lanzieri, and R. Gilkeson: *CT and MR Imaging of the Whole Body*, Volume 2, 4th ed. Philadelphia, Mosby, 2003. Copyright Elsevier, 2003.

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