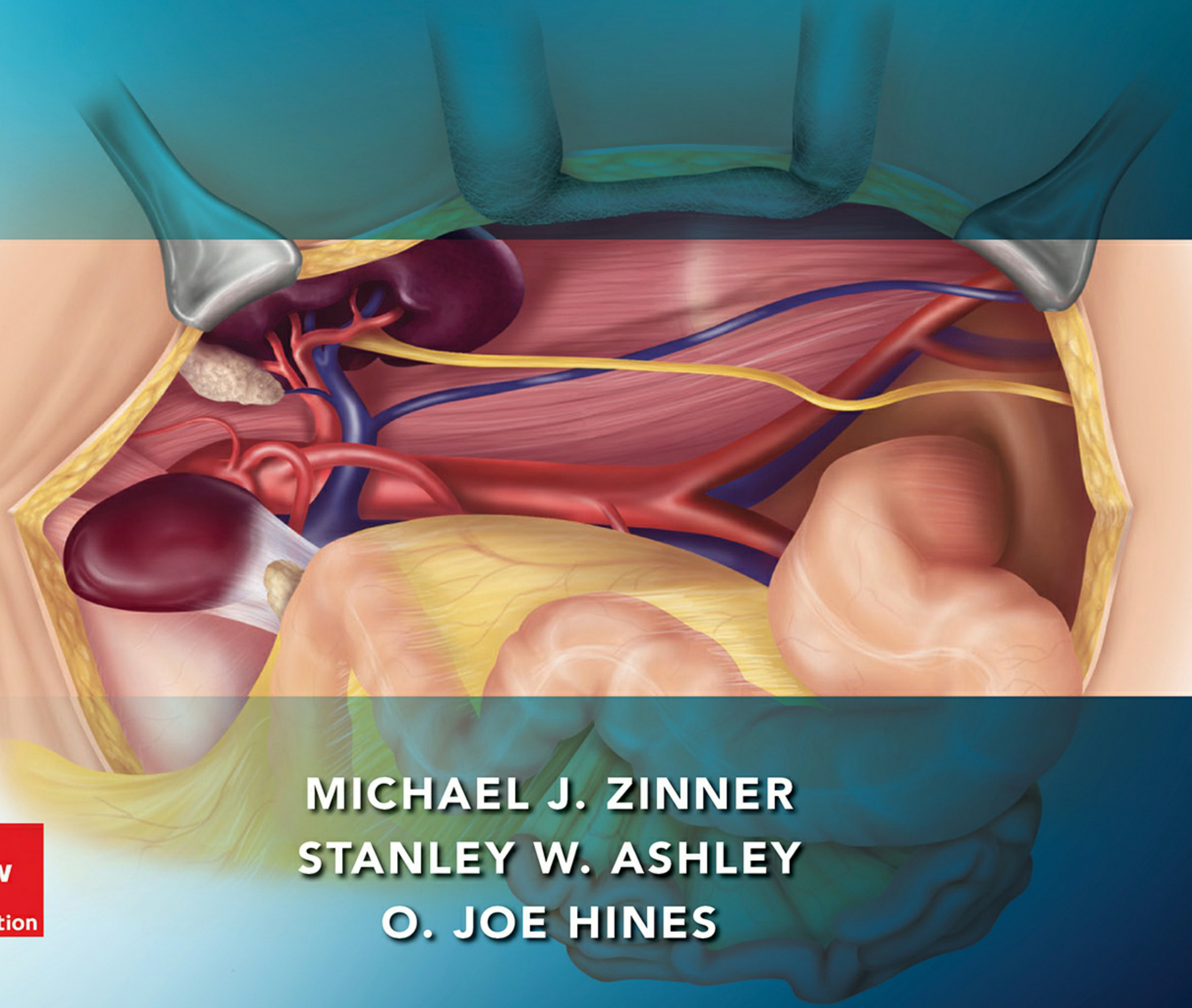
13th Edition

MAINGOT'S ABDOMINAL OPERATIONS



MICHAEL J. ZINNER
STANLEY W. ASHLEY
O. JOE HINES

Mc Graw Hill Education

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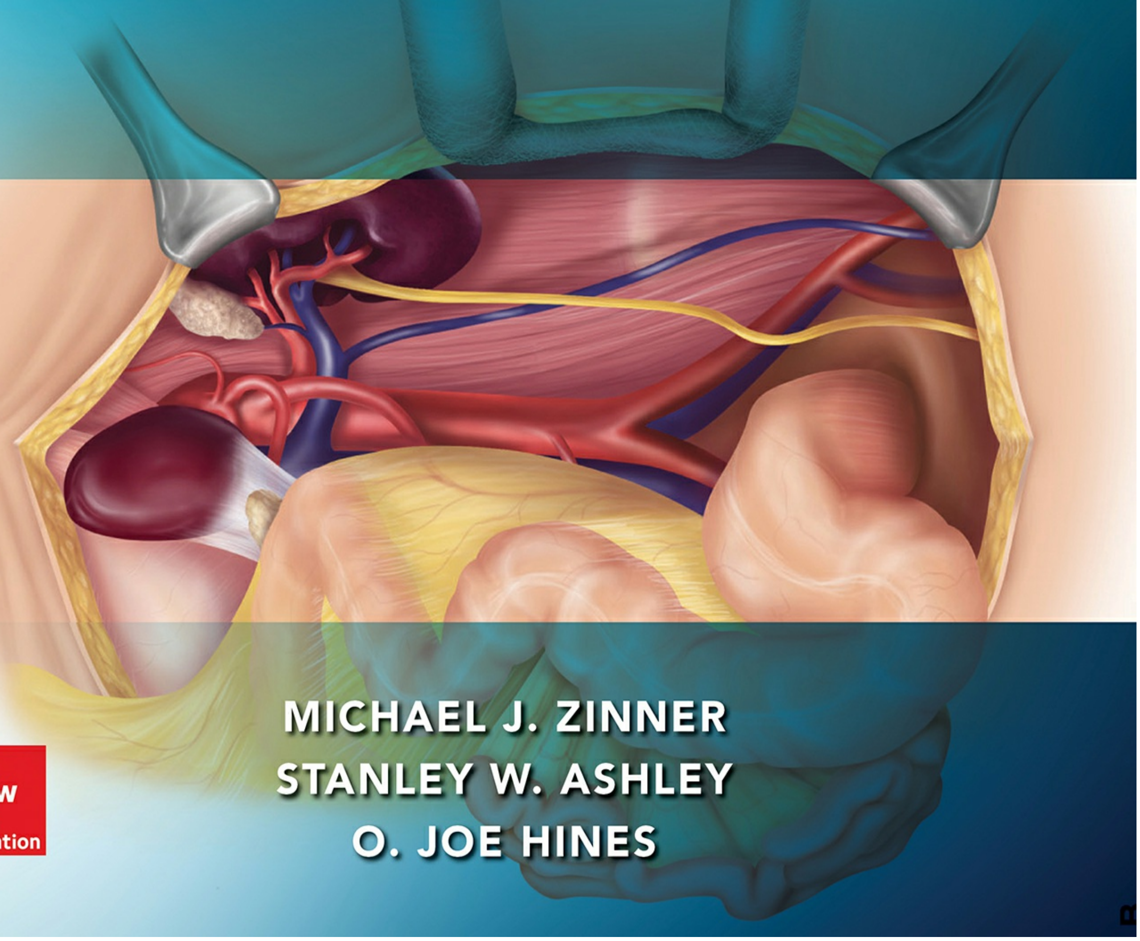

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Maingot's
ABDOMINAL OPERATIONS

Thirteenth Edition

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PREFACE

For the editors, the production of the newest edition of *Maingot's Abdominal Operations* represents a labor of love. *Maingot's* has always filled a unique niche. This text has consistently offered a comprehensive discussion of surgical diseases of the abdomen with a focus on operative strategy and technique. The book has served as a needed reference to refresh our knowledge before a common operation or in preparation for a novel one. Our intended audience for this edition is the same as for the original publication; the book is meant for the surgical trainee as well as the practicing surgeon, and for the American surgeon as well as for our international colleagues. We continue to have a significant international audience and have made every effort to develop a product that is equally valuable to readers in India as well as Indiana. This is the fifth effort together for the senior editors, joined this time by a new editor (O.J.H.) with a fresh vision; it continues to be not only a pleasure but an honor and a privilege to have the opportunity to co-edit the 13th edition of this classic textbook.

Abdominal surgery has clearly evolved since Rodney Maingot's first edition of this text in 1940. Not only has our knowledge base increased substantially, but the procedures themselves have become both more complex and less invasive. The current subspecialization in abdominal surgery, a consequence of these changes, continues to challenge the need for a comprehensive text. Abdominal disease has been increasingly parceled between foregut, hepatobiliary, pancreatic, colorectal, endocrine, acute care, and vascular specialists. The editors continue to believe, however, that the basic principles of surgical care in each of the anatomic regions have more similarities than differences. Experience in any one of these organs can inform and strengthen the approach to each of the others. In fact, in community hospitals and rural settings both nationally and internationally, practices spanning multiple subspecialties remain the norm. Few would question the need for the abdominal surgeon to be well versed in dealing with any unexpected disease that is encountered in the course of a planned procedure. For many of us, *Maingot's Abdominal Operations* has consistently helped to fill that need.

This textbook remains primarily disease focused, in addition to maintaining its organ/procedure format. The new edition of this textbook is a significant revision and, in many areas, a completely new book. We have continued to focus some chapters on technical operative procedures, whereas others elucidate new and continuing concepts in diagnosis and management of abdominal disease. The new edition is expanded compared with previous versions, and we have continued to present the opinions and knowledge of more than one expert. In areas where opinions and approaches differ, we have added even more "Perspective" commentaries by experts in the field who we expected might have distinct opinions about approaches and/or operative techniques. In response to recent developments, we have added chapters on quality metrics, enhanced recovery after surgery, and robotic surgery. We have attempted to maintain an international flavor and have included a cross-section of both seasoned senior contributors and new leaders in gastrointestinal surgery. We continue to provide a contemporary textbook on current diagnostic procedures and surgical techniques related to the management and care of patients with all types of surgical digestive disease.

An extensive artwork program was undertaken for this edition. Many line drawings have been recreated to reflect the contributors' preferred method for performing certain surgical procedures. Some of these drawings are new and give the book a more consistent look. In addition, this edition continues full-color text and color line art.

In the preface to the sixth edition, Rodney Maingot noted, "As all literature is personal, the contributors have been given a free hand with their individual sections. Certain latitude in style and expression is stimulating to the thoughtful reader." Similarly, we have tried to maintain consistency for the reader, but the authors have also been given a free hand in their chapter submissions.

We would like to thank the publisher, McGraw-Hill, and in particular Christie Naglieri and Andrew Moyer, for their unwavering support during the lengthy time of development of this project. Their guidance was invaluable to completing this project in a single comprehensive volume. Their suggestions and attention to detail made it possible to overcome the innumerable

problems that occur in publishing such a large textbook.

Finally, we want to acknowledge the expertise of each chapter and perspective contributor. Without their effort, this book would not have been possible. We acknowledge our editorial assistant, Linda Smith, who has survived the trials of this book; she has been invaluable, and we never would have been able to do it without her. Patrina Tucker and Heather Couture have also stepped up and made this project possible. We owe them a great debt of gratitude for helping with every step of the work. To all of those who have participated in the creation and publication of this text, we thank you very much.

Michael J. Zinner, MD, FACS
Stanley W. Ashley, MD, FACS
O. Joe Hines, MD, FACS

I

INTRODUCTION

1

GASTROINTESTINAL SURGERY: A HISTORICAL PERSPECTIVE

David L. Nahrwold

INTRODUCTION

Surgeons continue to have brilliant ideas and use amazing technology to bring safe and effective surgery to people all over the world, but it was not always so. The evolution of surgery to its present state has taken at least 200 years, and surgery is still evolving. Each of the many abdominal operations surgeons now performed has its own special history, from the idea that spawned it to the present state of its art. Abdominal operations were brought to fruition by innovative surgeons who carefully planned them and had the courage to perform them and the wisdom to modify and improve them.

Although the histories of all abdominal operations are interesting, a broader view of abdominal surgery puts those stories into perspective. The broader view is best obtained by asking: What enabled abdominal surgery to evolve to its present state? What were the barriers to the evolution of abdominal surgery? How were the barriers overcome, and who overcame them? Although recognizing the individuals who developed and perfected individual operations is important, the perspective of this chapter is on how modern abdominal surgery came about and how it was enabled.

THE EARLY PROBLEMS

Prior to the middle of the 19th century, few operations were done with the expectation that the patient would live and be cured of the disease for which it was performed. The fundamental barrier was the excruciating pain caused by opening the abdomen and manipulating its contents, even when tempered by the administration of alcohol or derivatives of opium such as laudanum and morphine. Patients often died from postoperative bleeding, dehydration, or malnutrition. But it was infection that was the bane of surgeons. Infections followed almost all operations. Wound infection and peritonitis were the killers of patients who had abdominal surgery. Without antibiotics or even standardized methods of dressing infected wounds, the consequences of infection were disastrous. Except in a few isolated instances, physicians knew that surgery was not a realistic therapeutic option until infection, hemorrhage, dehydration, and malnutrition could be alleviated or eliminated. Remarkable progress was made during the second half of the 19th century, enabling surgeons to bring hope to a large number of patients with diseases or conditions that swiftly became amenable to surgery.

ANESTHESIA

The modernization of abdominal surgery was dependent on the patient’s loss of sensation, anesthesia, during the procedure. The development of anesthesia eliminated the cruelty of surgery and enabled surgeons to incise, manipulate, and suture tissue in a disciplined manner without the urgency and disorder that surrounded operations in the conscious patient.

Dr. Crawford Long was the first to use ether for general anesthesia, in 1842, but he did not report it until 1849.[1] Meanwhile, in 1846, the Boston dentist William T.G. Morton demonstrated the use of ether as a general anesthetic in the amphitheater of the Massachusetts General Hospital in a patient with a tumor of the neck, which was removed by Dr. John Collins Warren, former Dean of the Harvard Medical School (1816-1819).[2]

OVERCOMING INFECTION

Louis Pasteur conducted experiments between 1860 and 1864 showing that "pyogenic vibrio" caused puerperal fever and that fermentation of wine and milk did not proceed in the absence of living organisms. Heating milk and wine, now called pasteurization, killed the bacteria, but not the yeast, and made them safe to drink.[3]

Robert Koch, the German physician and microbiologist who in 1876 identified *Bacillus anthracis* as the cause of anthrax, learned how to grow bacteria on media and, in 1884, isolated *Vibrio cholerae*, the agent that causes cholera. In 1882, Koch identified the slow-growing *Mycobacterium tuberculosis* as the cause of tuberculosis. Between 1879 and 1889, he also isolated the organisms that caused typhoid fever, diphtheria, pneumonia, tetanus, meningitis, and gonorrhea. He found organisms in wound infections. Koch proved that the germs in the germ theory of disease were organisms that could be isolated and identified.[4]

The English physician Joseph Lister, professor of surgery at the University of Glasgow, soaked surgical dressings in carbolic acid (phenol) and applied them to the open leg wound of a boy who had suffered a compound fracture (Fig. 1-1). No infection ensued, and to his surprise, the bones healed solidly together. He published the results in a series of articles in *The Lancet* in 1867. He returned to the University of Edinburgh in 1869 and continued to develop methods of asepsis and antisepsis. Soon, surgeons performed operations under a mist of dilute carbolic acid that was sprayed in the operating room, instruments were dipped in carbolic acid before use, and the surgical wound was covered in dressings saturated with it.[5] This routine, with variations, became known as listerism, which Joseph Lister introduced to the United States during a visit in 1876.

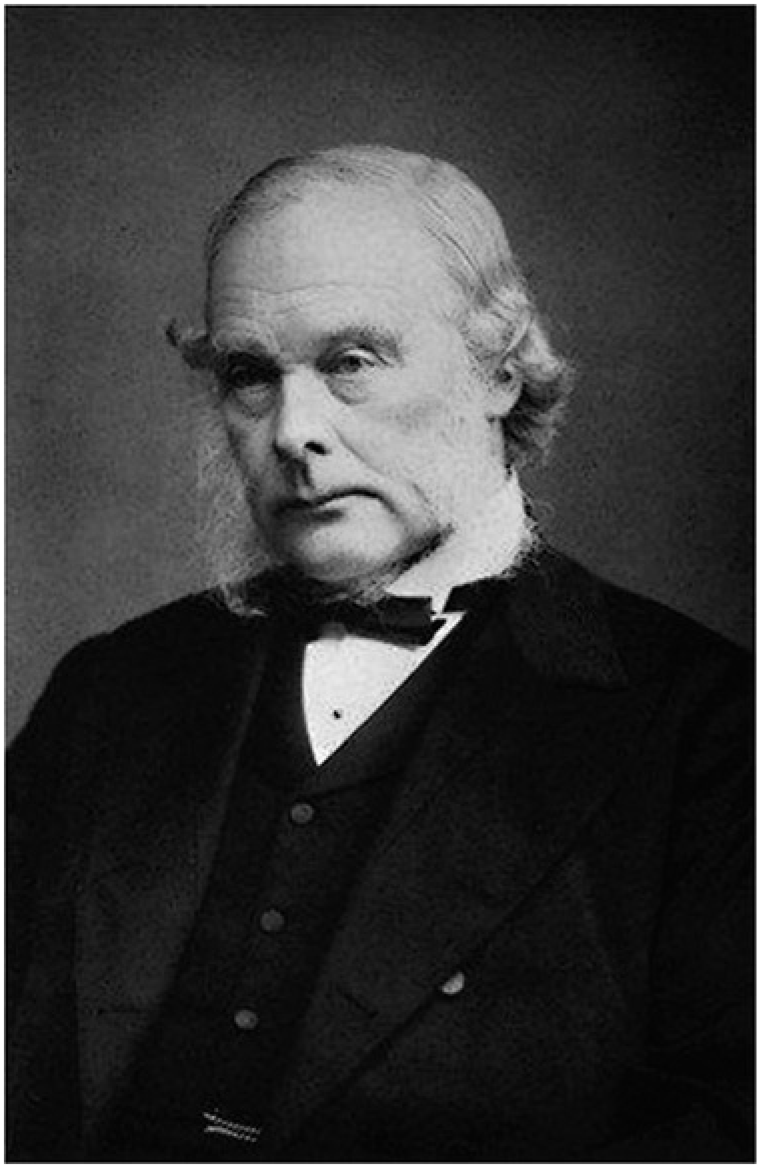

FIGURE 1-1 Joseph Lister. (Used with permission from Wellcome Images.)

Surgeons learned from listerism of the need to maintain sterile conditions at the operating table. Although the steam autoclave was invented in 1879, it was not used routinely for sterilization of instruments and supplies until early in the 20th century. Dr. William Halsted, who embraced listerism, introduced the use of surgical gloves at Johns Hopkins Hospital. However, the original use of the gloves made by the Goodyear Company was to protect the hands of the surgical team from the carbolic acid.[6]

Measures to control infection have been used routinely since the first half of the 20th century and affect hospital construction, all invasive procedures, interactions with patients, and behaviors in hospitals and other medical facilities.

The medicinal use of sulfa drugs in the late 1930s, the discovery of penicillin in 1928 by Fleming, and its clinical use by Florey and his colleagues in the early 1940s began the successful search for many other antibiotics to combat infections by almost all known bacteria. During the second half of the 20th century and beyond, surgical infections have been ameliorated or cured by the large array of antibiotics that became available, although antibiotic-resistant bacteria from antibiotic overuse have recently become a problem. In recent decades, the evidence-based prophylactic use of antibiotics in abdominal surgery has almost eliminated surgical site infections.

THE SURGEON'S WORKPLACE

Hospitals were built to provide clinical material for the faculties and students of the country's original medical schools. They included the Pennsylvania Hospital (1752), the New York Hospital (1771), and the Massachusetts General Hospital (1811), all of which became the workplaces of innovative physicians and surgeons who taught and conducted research (Fig. 1-2). However, most cities had no hospitals; instead, almshouses, poorhouses, and poor farms, living facilities for indigent people in the community were established by charitable organizations and wealthy individuals. Over time, many of them became hospitals for the sick and poor. Some physicians also established hospitals, often by converting a large home into a place for their sick patients. Many hospitals were dirty and poorly kept, and because some of the occupants had infectious diseases for which there were no cures, the other occupants also became infected and often died.

FIGURE 1-2 The Pennsylvania Hospital. (Reproduced with permission from The Library of Congress.)

Because hospitals were known as dangerous places, middle- and upper-class families kept sick relatives at home. The typical horse-and-buggy doctor made rounds to the homes of his patients, and minor procedures, such as drainage of a carbuncle or suture of a wound, were performed in the home. Occasionally, a physician whose patient was in desperate straits would attempt an abdominal operation on the kitchen table, usually with disastrous results.

As medical diagnosis and treatment advanced, medical care in the home was no longer practical. Beginning in the latter half of the 19th century, religious organizations, civic groups, and municipalities began aggressive programs to build hospitals modeled after those in Europe, and by 1900, there were more than 4000 hospitals in the United States. However, the management, medical staffs, nursing, and other services of these hospitals varied from excellent to poor.

THE HOSPITAL STANDARDIZATION PROGRAM IMPROVES HOSPITALS

Dr. Franklin H. Martin, a Chicago gynecologist, led the founding of the American College of Surgeons (ACS) in 1912 (Fig. 1-3). He and other leaders of the ACS were concerned about the marked variation in the quality of hospitals throughout the country and began a program to standardize hospitals in 1916 by establishing standards that hospitals were required to meet.[7] Surveyors visited the hospitals to determine their compliance and to offer help in meeting the standards. The ACS also held annual hospital standardization conferences to educate hospital personnel. The American Hospital Association, which initiated institutional memberships in 1918, also contributed to the modernization of hospital management.

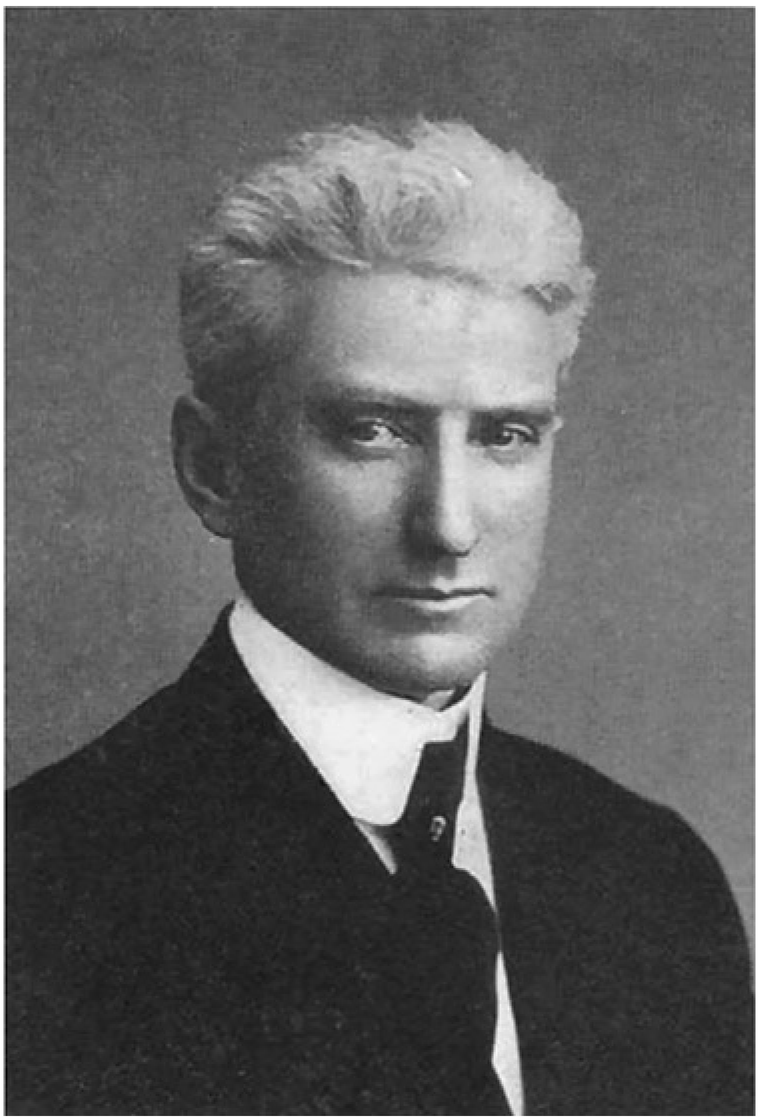

FIGURE 1-3 Dr. Franklin H. Martin, Founder of the American College of Surgeons. (Image courtesy of the Archives of the American College of Surgeons.)

Only 13% of the 692 hospitals surveyed in 1918 were approved by the ACS, but by 1939, 76% of the 3564 hospitals surveyed were approved.[8] Over the years, the standards proliferated, and in 1951, the ACS transferred the program to what is now The Joint Commission.

The Hospital Standardization Program and The Joint Commission were largely responsible for the current organization and functions of the modern hospital. The standards they set have saved many lives and made surgery safe.

NURSING AND HOSPITAL ADMINISTRATION

Although hospitals proliferated early in the 20th century, few of them hired nurses to care for patients. Graduate nurses were hired by middle- and upper-class patients as "special nurses" to care for them in their homes or in the hospital during illnesses. To serve patients who could not afford special nurses, hospitals established schools of nursing in which the students were taught by a faculty of 1 or 2 graduate nurses and the medical staff of the hospital. Student nurses were assigned to wards to care for patients, often with very little supervision. Many of these schools closed during the Great Depression, and later, colleges and universities established degree programs, which now educate most of the country's nurses. Prior to World War II, the supply of graduate nurses became sufficient for hospitals to hire nursing staffs to care for their patients. As the complexity of medical care escalated, nurses assumed many roles other than hospital care, and they continue to be indispensable to the healthcare system.

During the first half of the 20th century, when hospitals were simple organizations, hospital administrators learned from a mentor or on the job. By the middle of the century, hospitals had become departmentalized and complex, requiring expertise in finance, personnel management, construction, and many other fields of management. This led to the development of advanced degree programs in hospital administration, the first of which was established at the University of Chicago in 1934. Within a few decades, many universities had established such programs.

APPLYING THE BASIC SCIENCES

Although the gross structure of the human body and its organs had been delineated by the middle of the 19th century, the functions of organs remained mysterious. Concurrent development of the basic sciences of pathology, microbiology, physiology, and chemistry during the second half of the 19th century led to an understanding of organ function and disease. During this period, Rudolph Virchow, using the ever-improving optics of the microscope, introduced histopathology to the medical sciences, and Friedrich von Recklinghausen described embolism, infarction, tissue degeneration, and many diseases and conditions such as uterine adenomyomata. Improved techniques for fixing, embedding, and staining tissue facilitated more accurate diagnoses in the early 20th century, and the process of preparing frozen sections of tissues, reported by Dr. Louis Wilson of the Mayo Clinic in 1905, enabled pathologists to accurately diagnose diseases during operations.[9]

New techniques enabled investigators to understand normal and abnormal gastrointestinal physiology. Between the 1890s and his death in 1936, the Russian physiologist Ivan Pavlov used Heidenhain pouches and gastric and esophageal fistulas in dogs to study salivary and gastric secretions as well as conditioned reflexes, work for which he received the Nobel Prize.[10] His experiments inspired many surgical investigators to use similar methods to study gastrointestinal hormonal physiology and motility during the 20th century. Their work, and the work of others, resulted in a comprehensive understanding of the biochemistry, physiology, and pharmacology of the hepatobiliary and digestive systems in health and disease.

Army surgeon Dr. William Beaumont performed the first human experiments in gastric physiology during the first half of the 19th century,[11] but it was not until Dr. Lester Dragstedt studied gastric secretion in ulcer patients that gastrointestinal physiology was applied to the development of surgical procedures to combat excessive acid secretion. He introduced vagotomy to reduce gastric acid secretion.[12] Upon finding that vagotomy inhibited gastric emptying, he and others added pyloroplasty or antrectomy.

Beginning with the administration of intravenous fluids to surgical patients by Dr. Rudolph Matas in 1924, many advances in biochemistry and physiology led to a greater understanding of body composition, nutrition, and fluid, electrolyte, and acid-base balance. The studies of Dr. Francis Moore and others culminated in his magisterial text, *Metabolic Care of the Surgical*

Patient, which taught surgeons how to deliver the highest level of pre- and postoperative care.[13] Drs. Jonathan Rhoads and Stanley Dudrick emphasized the importance of nutrition in surgical patients and demonstrated that intravenous alimentation could support normal growth and development of puppies and babies.[14]

The basic science of immunology matured during the 20th century, enabling the first kidney transplantation by Dr. Joseph Murray and his associates in 1954 and the first liver transplantation by Dr. Thomas Starzl in 1963.

BLOOD, TRAUMA, AND SHOCK

After Karl Landsteiner identified the major blood groups A, B, and O in 1901, transfusion of blood and blood products became safer. Dr. George W. Crile, professor of surgery at Case-Western Reserve University, and Dr. William Halsted of The Johns Hopkins Hospital employed blood transfusions during surgical procedures. Reactions to transfusions were frequent until 1940, when the Rh system was discovered and taken into account in matching donor blood to patients. Dr. Bernard Fantus established the first hospital blood bank in the United States at Cook County Hospital in Chicago in 1937.[15]

Liquid and reconstituted dried plasma was used extensively for resuscitation from wounds during World War II. Lessons learned from the Korean conflict, the Vietnam War, and subsequent conflicts have been applied to the management of civilian trauma and burns, especially the techniques of resuscitation from shock, which were studied extensively by Dr. G Thomas Shires and his colleagues.[16] The wartime concepts of rapid evacuation for resuscitation and early transport to a major healthcare facility are embodied in the existing trauma system in the United States. The military experience has also informed the management of abdominal gunshot and knife wounds and blunt abdominal injuries in the civilian population.

THE SURGEON’S TOOLS

More than 200 years have elapsed since Ephraim McDowell performed the first abdominal operation in the United States to remove a huge ovarian tumor from a woman in Danville, Kentucky.[17] Subsequently, and especially during the latter half of the 19th century, operations were developed in Europe and the United States to deal with almost every abdominal disease or condition. The need to design and manufacture surgical instruments spawned an entirely new field, biomedical engineering, which became institutionalized in the late 1960s when universities began degree programs in biomedical engineering. The manufacture of surgical instruments and supplies is now vested in a huge industry that produces products ranging from silk sutures to robots.

Manufacture of most surgical instruments was routine by the beginning of the 20th century, including retractors, hemostats, scissors, forceps, and a variety of tools designed to grasp, hold, or manipulate abdominal organs and tissues. Improvements such as the disposable scalpel blade in the 1920s and disposable instruments in the 1970s have reduced labor costs of hospitals. The introduction of staplers for gastrointestinal side-to-side and end-to-end anastomoses by Russian investigators, brought to the United States and developed by Ravitch and Steichen[18] in the 1960s, was a major advance.

Hemostasis was facilitated by the development of a diathermy machine for electrosurgical cutting and cautery by William T. Bovie and introduced into clinical use by Harvey Cushing at the Peter Bent Brigham Hospital in 1920, eliminating the need to clamp and ligate small vessels. Since then, topical preparations, clips, electrical energy, and ultrasonic energy have been incorporated into various devices that have enabled minimally invasive surgery.

TECHNOLOGY DRIVES SURGERY

Development of minimally invasive surgery was dependent on the visualization of organs in the abdominal cavity through a scope. In 1806, Phillipp Bozzini made a major contribution by constructing a “lichtleiter,” a scope that incorporated mirrors to reflect light back to the eye. It was used primarily for gynecologic examinations (Fig. 1-4). The development of small bulbs illuminated by electric current enabled laparoscopy for diagnosis beginning in the first half of the 20th century, and flexible fiberoptic scopes for examining the interior of the gastrointestinal tract followed in the 1950s.

FIGURE 1-4 Bozzini's lichtleiter. (Image courtesy of the Archives of the American College of Surgeons.)

Numerous advances in technology, many driven by the computer and the computer chip television camera, enabled laparoscopic surgery, which revolutionized abdominal surgery.

Laparoscopic surgery had its origin in obstetrics and gynecology, with the first laparoscopic organ removal, salpingectomy, performed by Tarasconi in 1975.[19] This was followed by laparoscopic cholecystectomy, first performed by Muhe in Germany in 1985, by Mouret in France in 1987, and Reddick in the United States in 1988.[20] Since then, every abdominal organ has been subjected to laparoscopic procedures.

The most recent technological development is the use of robots in surgery. After years of research and development by many organizations, the da Vinci surgery system was approved by the US Food and Drug Administration in 2000 for general laparoscopic surgery. The surgeon sits at a console where the interior of the abdomen is projected on a screen and uses a computer to control a robotic arm to which are attached various instruments. Newer versions, including a console for an assistant, have been used in general surgery and the surgical specialties. The advantages and disadvantages of robotic surgery are still under evaluation as experience accumulates and the technology continues to improve.

SUMMARY

Early abdominal surgery was enabled by the discovery of general anesthesia, means to control or eliminate infection, and the evolution of the hospital, where patients could be housed and surgeons could work in a supportive environment that included nurses and hospital administrators. Later, development of the basic sciences enabled the development of new operations and methods to deal with altered physiology and body chemistry caused by illness, trauma, and complex surgical procedures. Most recently, striking advances in technology have enabled the development of minimally invasive and robotic surgery.

REFERENCES

1. Long CW. An account of the first use of sulphuric ether by inhalation as an anesthetic in surgical operations. *South Med Surg J*. 1849;5:705-713.
2. Keys TE. William Thomas Green Morton (1819-1868). *Anesth Analg*. 1973;52(2):166.
3. Schwartz M. The life and works of Louis Pasteur. *J Appl Microbiol*. 2001;91(4):597-601.
4. Blevins SM, Bronze MS. Robert Koch and the “golden age” of bacteriology. *Int J Infect Dis*. 2010;14(9):e744-e751.
5. Lister Centenerary Celebration. American College of Surgeons. Detroit, MI, October, 1927; Descriptive Catalogue. Lister Collection. 1927; Wellcome Historical Medical Museum.
6. Cameron JC. William Stewart Halsted: our surgical heritage. *Ann Surg*. 1997;225(5):445-458.
7. Nahrwold DL, Kernahan PJ. *A Century of Surgeons and Surgery. The American College of Surgeons 1913-2012*. Chicago, IL: American College of Surgeons; 2012.
8. Twenty-second annual hospital standardization report. *Bull Am Col Surg*. 1939;24(5):316.
9. Wilson LB. A method for the rapid preparation of fresh tissues for the microscope. *JAMA*. 1905;45:1737.
10. Babkin BP. *Pavlov, a Biography*. Chicago, IL: The University of Chicago Press; 1939.
11. Myer JS. *Life and Letters of Dr. William Beaumont*. St. Louis, MO: CV Mosby Company; 1939:327.
12. Dragstedt LR, Owens FM Jr. Supra-diaphragmatic section of the vagus nerves in treatment of duodenal ulcer. *Proc Soc Exp Biol Med*. 1943;53:152-154.
13. Moore FD. *Metabolic Care of the Surgical Patient*. Philadelphia, PA: WB Saunders; 1959.
14. Dudrick SJ, Rhoads JE. New horizons for intravenous feeding. *JAMA*. 1971;215(6):939-949.
15. Fantus B. The therapy of the Cook County Hospital: blood preservation. *JAMA*. 1938;111(4):317.
16. Shires GT. *Shock and Related Problems*. London, United Kingdom: Churchill Livingstone; 1984.

17. Rutkow IM. *The History of Surgery in the United States, 1775-1900*. Vol 2. Novato, CA: Norman Publishing; 1988.
18. Steichen FH, Ravitch MM. *Stapling in Surgery*. Chicago, IL: Year Book Medical; 1971.
19. Tarasconi JC. Endoscopic salpingectomy. *J Reprod Med*. 1981;26(10): 541-545.
20. Blum CA, Adams DB. Who did the first laparoscopic cholecystectomy? *J Minim Access Surg*. 2011;7(3):165-168.

2

PREOPERATIVE AND POSTOPERATIVE MANAGEMENT

Zara Cooper • Edward Kelly

Surgeons of every specialty face increasingly complex surgical challenges. In addition, modern surgical treatment can be offered to more fragile patients, with successful outcomes. Mastery of the scientific fundamentals of perioperative management is required to achieve satisfactory results. The organ system–based approach presented here allows the surgeon to address the patient’s pre- and postoperative needs with a comprehensive surgical plan. This chapter will serve as a summary guide to best practices integral to conducting surgical procedures in the modern era.

MANAGEMENT OF PAIN AND DELIRIUM

The most common neuropsychiatric complications following abdominal surgery are pain and delirium. Moreover, uncontrolled pain and delirium prevent the patient from contributing to vital aspects of his or her care, such as ambulation and respiratory toilet, and promote an unsafe environment that may lead to the unwanted dislodgment of drains and other supportive devices, with potentially life-threatening consequences. Pain and delirium usually coexist in the postoperative setting, and each can contribute to the development of the other. Despite high reported rates of overall patient satisfaction, pain control is frequently inadequate in the perioperative setting,[1] with high rates of complications such as drowsiness from overtreatment and unacceptable levels of pain from undertreatment. Therefore, it is mandatory that the surgical plan for every patient include close monitoring of postoperative pain and delirium and regular assessment of the efficacy of pain control.

Pain management, like all surgical planning, begins in the preoperative assessment. In the modern era, a large proportion of surgical patients will require special attention with respect to pain control. Patients with preexisting pain syndromes, such as sciatica or interspinal disc disease, or patients with a history of opioid use may have a high tolerance for opioid analgesics. Every patient's history should include a thorough investigation for chronic pain syndrome, addiction (active or in recovery), and adverse reactions to opioid, nonsteroidal, or epidural analgesia. The pain control strategy may include consultation with a pain control anesthesiology specialist, but it is the responsibility of the operating surgeon to identify complicated patients and construct an effective pain control plan.

Opioid Analgesia

Postoperative pain control using opioid medication has been in use for thousands of years. Hippocrates advocated the use of opium for pain control. The benefits of postoperative pain control are salutary and include improved mobility and respiratory function and earlier return to normal activities. The most effective strategy for pain control using opioid analgesia is patient-controlled analgesia (PCA), wherein the patient is instructed in the use of a preprogrammed intravenous pump that delivers measured doses of opioid (usually morphine or meperidine). In randomized trials, PCA has been shown to provide superior pain control and patient satisfaction compared to interval dosing,[2] but PCA has not been shown to improve rates of pulmonary and cardiac complications[3] or length of hospital stay,[4] and there is evidence that PCA may contribute to postoperative ileus.[5] In addition, PCA may be unsuitable for patients with a history of substance abuse, high opioid tolerance, or those with atypical reactions to opioids.

Regional Analgesia

Due to the limitations of PCA, pain control clinicians have turned to regional analgesia as an effective strategy for the management of postoperative pain. Postoperative epidural analgesia involves the insertion of a catheter into the epidural space of the lumbar or thoracic spine, enabling the delivery of local anesthetics or opioids directly to the nerve roots. The insertion procedure is generally safe, with complication rates of motor block and numbness between 0.5% and 7%,[6] and an epidural abscess rate of 0.5 per thousand.[7] Potential advantages of epidural analgesia include elimination of systemic opioids, and thus less respiratory depression, and improvement in pulmonary complications and perioperative ileus. There have been several large trials,[8-10] a meta-analysis,[6] and a systematic review[11] comparing PCA with epidural analgesia in the setting of abdominal surgery. These studies indicate that epidural analgesia provides more complete analgesia than PCA throughout the postoperative course. Furthermore, in randomized prospective series of abdominal procedures, epidural analgesia has been associated with decreased rates of pulmonary complications[12,13] and postoperative ileus.[14,15] Epidural analgesia requires a skilled anesthesia clinician to insert and monitor the catheter and adjust the dosage of neuraxial medication. Some clinicians may prefer correction of coagulopathy before inserting or removing the catheter, although the American Society of Anesthesiologists (ASA) has not issued official guidelines on this issue.

Peripheral nerve blocks are also effective in perioperative pain control and do not carry the same potential morbidities as the epidural approach. Using ultrasound guidance, a skilled practitioner can deliver a long-acting local anesthetic into the transversus abdominis plane (TAP) or in the rectus sheath to establish analgesia both intraoperatively and postoperatively. Randomized clinical data have confirmed the efficacy of regional blocks in controlling pain and reducing use of opioid analgesia.[16,17]

Analgesia with Nonsteroidal Anti-Inflammatory Drugs

Oral nonsteroidal anti-inflammatory drugs (NSAIDs) have long been used for postoperative analgesia in the outpatient setting and, with the development of parenteral preparations, have come into use in the inpatient population. This class of medication has no respiratory side effects and is not associated with addiction potential, altered mental status, or ileus. In addition, these medications provide effective pain relief in the surgical population. However, use of NSAIDs has not been universally adopted in abdominal surgery due to concerns regarding the platelet dysfunction and erosive gastritis associated with heavy NSAID use. In prospective trials, NSAIDs were found to provide effective pain control without bleeding or gastritis symptoms following laparoscopic cholecystectomy,[18] abdominal hysterectomy,[19] and inguinal hernia repair.[20,21] NSAIDs have also been shown to improve pain control and decrease morphine dosage when used in combination following appendectomy.[22]

The sensation of pain is very subjective and personal. Accordingly, the surgeon must individualize the pain control plan to fit the needs of each patient. The pain control modalities discussed above can be used in any combination, and the surgeon should not hesitate to use all resources at his or her command to provide adequate relief of postoperative pain.

Postoperative Delirium

Delirium, defined as acute cognitive dysfunction marked by fluctuating disorientation, sensory disturbance, and decreased attention, is an all too common complication of surgical procedures, with reported rates of 11% to 25%, with the highest rates reported in the elderly population.[23,24] The postoperative phase of abdominal surgery exposes patients, some of whom may be quite vulnerable to delirium, to a large number of factors that may precipitate or exacerbate delirium (Table 2-1). These factors can augment one another: postoperative pain can lead to decreased mobility, causing respiratory compromise, atelectasis, and hypoxemia. Escalating doses of narcotics to treat pain can cause respiratory depression and respiratory acidosis. Hypoxemia and delirium can cause agitation, prompting treatment with benzodiazepines, further worsening respiratory function and delirium. This vicious cycle can result in serious complications or death. Preoperative recognition of high-risk patients and meticulous monitoring of every patient’s mental status are the most effective ways to prevent postoperative delirium; treatment can be remarkably difficult once the cycle has begun.

TABLE 2-1: CAUSES OF PERIOPERATIVE DELIRIUM

Pain
Narcotic analgesics
Sleep deprivation
Hypoxemia
Hyperglycemia
Acidosis
Withdrawal (alcohol, narcotics, benzodiazepines)
Anemia
Dehydration
Electrolyte imbalance (sodium, potassium, magnesium, calcium, phosphate)
Fever
Hypotension
Infection (pneumonia, incision site infection, urinary tract infection)
Medication (antiemetics, antihistamines, sedatives, anesthetics)
Postoperative myocardial infarction

Patient factors that are associated with high risk of perioperative delirium include age greater than 70 years, preexisting cognitive impairment or prior episode of delirium, history of alcohol or narcotic abuse, and malnutrition.[22,25] Procedural factors associated with high delirium risk include operative time greater than 2 hours, prolonged use of restraints, presence of a urinary catheter, addition of more than 3 new medications, and reoperation.[26]

Once the patient's risk for postoperative delirium is identified, perioperative care should be planned carefully to decrease other controllable factors. Epidural analgesia has been associated with less delirium than PCA after abdominal surgery.[26] Sedation or "sleepers" should be used judiciously, if at all, with high-risk patients. If the patient requires sedation, neuroleptics such as haloperidol and the atypical neuroleptics such as olanzapine are tolerated much better than benzodiazepines.[27] The patient's mental status, including orientation and attention, should be assessed with every visit and care should be taken to avoid anemia, electrolyte imbalances, dehydration, and other contributing factors.

Once the diagnosis of postoperative delirium is established, it is important to recognize that some of the causes of delirium are potentially life-threatening, and immediate action is necessary. Evaluation begins with a thorough history and physical examination at the bedside by the surgeon. The history should focus on precipitating events such as falls (possible traumatic brain injury), recent procedures, use of opioids and sedatives, changes in existing medications (eg, withholding of thyroid replacement or antidepressants), and consideration of alcohol withdrawal. The vital signs and fluid balance may suggest sepsis, hypovolemia, anemia, or dehydration. The exam should include brief but complete sensory and motor neurologic examinations to differentiate delirium from stroke. Pay attention to common sites of infection such as the surgical wound, the lungs, and intravenous catheters. Urinary retention may be present as a result of medication or infection. Deep venous thrombosis may be clinically evident as limb swelling. Postoperative myocardial infarction (MI) may often present as acute cardiogenic shock.

The history and physical examination should then direct the use of lab tests. Most useful are the electrolytes, blood glucose, and complete blood cell count. Pulse oximetry and arterial blood gases may disclose hypercapnia or hypoxemia. Chest x-ray may disclose atelectasis, pneumonia, acute pulmonary edema, or pneumothorax. Cultures may be indicated in the setting of fever or leukocytosis, but will not help immediately. Electrocardiogram (ECG) and cardiac troponin may be used to diagnose postoperative MI.

Resuscitative measures may be required if life-threatening causes of delirium are suspected. Airway control, supplemental oxygen, and fluid volume expansion should be considered in patients with unstable vital signs. The patient should not be sent out of the monitored environment for further tests, such as head computed tomography (CT), until the vital signs are stable and the agitation is controlled. Treatment of postoperative delirium depends on treatment of the underlying causes. Once the underlying cause has been treated, delirium may persist, especially in elderly or critically ill patients, who regain orientation and sleep cycles slowly. In these patients, it is important to provide orienting communication and mental stimulation during the day and to promote sleep during the night. The simplest ways are the most effective: contact with family members and friends, use of hearing aids, engagement in activities of daily living, and regular mealtimes. Sleep can be promoted by keeping the room dark and quiet throughout the evening and preventing unnecessary interruptions. If nighttime sedation is required, atypical neuroleptics or low-dose serotonin reuptake inhibitors such as trazodone are better tolerated than benzodiazepines. If agitation persists, escalating doses of neuroleptics (or benzodiazepines in the setting of alcohol withdrawal) can be used to control behavior, but underlying organic causes of delirium must be investigated.

CARDIAC EVALUATION

Risk Assessment

It has been estimated that 1 million patients have a perioperative MI each year, and the contribution to medical costs is $20 billion annually.[28] Thoracic, upper abdominal, neurologic, and major orthopedic procedures are associated with increased cardiac risk. Diabetes, prior MI, unstable angina, and decompensated congestive heart failure (CHF) are most predictive of perioperative cardiac morbidity and mortality, and patients with these conditions undergoing major surgery warrant further evaluation[29] (Table 2-2). Patient factors conferring intermediate risk include mild angina and chronic renal insufficiency with baseline creatinine ≥2 mg/dL.[30] It is worth noting that women were underrepresented in the studies on which the American College of Cardiology and the American Heart Association (ACC/AHA) guidelines are based.[31] A retrospective study in gynecologic patients found that hypertension and previous MI were major predictors of postoperative cardiac events, as opposed to the ACC/AHA guidelines, which indicate that they are minor and intermediate criteria, respectively.[32] Vascular surgical patients are at highest risk because of the prevalence of underlying coronary disease in this population.[29,33] Other high-risk procedural factors include emergency surgery, long operative time, and high fluid replacement volume. Intraperitoneal procedures, carotid endarterectomy, thoracic surgery, head and neck procedures, and orthopedic procedures carry an intermediate risk and are associated with a 1% to 5% risk of a perioperative cardiac event.[30]

TABLE 2-2: CLINICAL PREDICTORS OF INCREASED RISK FOR PERIOPERATIVE CARDIAC COMPLICATIONS

Major

Recent myocardial infarction (within 30 days)

Unstable or severe angina

Decompensated congestive heart failure

Significant arrhythmias (high-grade atrioventricular block, symptomatic ventricular arrhythmias with underlying heart disease, supraventricular arrhythmias with uncontrolled rate)

Severe valvular disease

Intermediate

Mild angina

Any prior myocardial infarction by history or electrocardiogram

Compensated or prior congestive heart failure

Diabetes mellitus

Renal insufficiency

Minor

Advanced age

Abnormal electrocardiogram

Rhythm other than sinus (eg, atrial fibrillation)

Poor functional capacity

History of stroke

Uncontrolled hypertension (eg, diastolic blood pressure >10 mm Hg)

Perioperative evaluation to identify patients at risk for cardiac complications is essential in minimizing morbidity and mortality. Workup should start with history, physical exam, and ECG to determine the existence of cardiac pathology. Screening with chest radiographs and ECG is required for men over 40 and women over 55. According to the ACC/AHA guidelines, initial preoperative cardiac risk can be assessed using a clinical calculator, the

Revised Cardiac Risk Index (RCRI).[34] This index includes history of ischemic heart disease, CHF, cerebrovascular disease, diabetes, chronic kidney disease, and planned high-risk procedure. Advanced or invasive testing is reserved for patients with 2 or more of these risk factors. Overall functional ability is the best clinical measure of cardiac fitness. Patients who can exercise without limitations can generally tolerate the stress of major surgery.[35] Limited exercise capacity may indicate poor cardiopulmonary reserve and the inability to withstand the stress of surgery. Poor functional status is the inability to perform activities such as driving, cooking, or walking less than 5 km/h.

Intraoperative risk factors include operative site, inappropriate use of vasopressors, and unintended hypotension. Intra-abdominal pressure exceeding 20 mm Hg during laparoscopy can decrease venous return from the lower extremities and thus contribute to decreased cardiac output,[36] and Trendelenburg positioning can result in increased pressure on the diaphragm from the abdominal viscera, subsequently reducing vital capacity. Intraoperative hypertension has not been isolated as a risk factor for cardiac morbidity, but it is often associated with wide fluctuations in pressure and has been more closely associated with cardiac morbidity than intraoperative hypotension. Preoperative anxiety can contribute to hypertension even in normotensive patients. Patients with a history of hypertension, even medically controlled hypertension, are more likely to be hypertensive preoperatively. Those with poorly controlled hypertension are at greater risk of developing intraoperative ischemia, arrhythmias, and blood pressure derangements, particularly at induction and intubation. Twenty-five percent of patients will exhibit hypertension during laryngoscopy. Patients with chronic hypertension may not necessarily benefit from lower blood pressure during the preoperative period because they may depend on higher pressures for cerebral perfusion. Those receiving antihypertensive medications should continue them up until the time of surgery. Patients taking β-blockers are at risk of withdrawal and rebound ischemia. Key findings on physical examination include retinal vascular changes and an S_4 gallop consistent with left ventricular hypertrophy. Chest radiography may show an enlarged heart, also suggesting left ventricular hypertrophy.

ECG should be obtained in patients with chest pain, diabetes, prior revascularization, prior hospitalization for cardiac causes, all men age 45 or