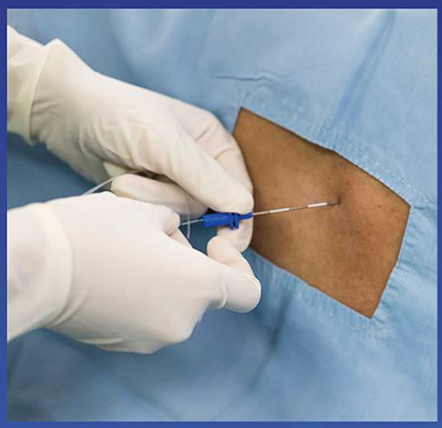
Anesthesiology

THIRD EDITION





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Anesthesiology

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"Life is no brief candle to me; it is a sort of splendid torch which I've got a hold of for the moment and I want to make it burn as brightly as possible before handing it on to future generations."

George Bernard Shaw
Irish playwright (1856–1950)

The editors were fortunate indeed to have outstanding mentors who dedicated their professional lives to the development of our generation in the specialty. Through their guidance, wisdom, and actions, they truly handed the torch to us. As their progeny, we are ever grateful for both their professional guidance and their personal friendship. In recognition of their influence on us individually, and the specialty overall, we dedicate this book to:

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Preface

Anesthesiology, and indeed all of US health care, is influenced currently by four dominant trends. First, the passage of the Patient Protection and Affordable Care Act (PPACA) of 2010 demonstrated an enhanced national commitment to access to health care. Second, it underscored that such care must be *affordable*, that is, more efficient and cost effective. These two principles are now well established and will likely persist, although structural details may vary depending on national policy and political preference. Third, the emphasis on quality and safety in health care has gained even greater momentum. Fourth, the national burden of illness is magnified by a US population that is aging rapidly, resulting in over 10,000 new Medicare enrollees daily. Collectively, these trends have led to the development of alternative payment models that reward value, not volume of services, and that further emphasize the role of patient choice in the care process. We believe these trends will be dominant themes for many years to come, and they are guiding principles in the current edition of this text.

Fortunately, the specialty of anesthesiology is well positioned to lead these initiatives. Anesthesiology is already recognized as the pioneering leader in patient safety, and we see no reason why anesthesiologists and anesthesia teams should not be leaders in efficiency, value, and patient choice in health care as well. Indeed, we believe that continuing to position our specialty at the forefront of these initiatives is a key strategy for both the current and future success of anesthesiology and its practitioners.

In 2000, the Institute of Medicine (IOM; renamed the National Academy of Medicine in 2015) published its landmark analysis of American health care, "To Err Is Human," a treatise that emphasized the fallibility of even highly motivated humans and that systems of safe care must be constructed to protect patients from potential harm. That report specifically cited anesthesiology as a leader in the patient safety movement and urged other disciplines to follow, which many have done subsequently. Another IOM publication, "Crossing the Quality Chasm; A New Health System for the 21st Century" (2001), described the attributes of a model health care system that is safe, timely, efficient, effective, patient centered, and equitable to all.

The PPACA legislation underscored these principles, and subsequent regulations translated them into operational policies and practices. We agree with these principles and have worked diligently to adopt them in our own practices and departments, for they are guideposts to the professional and ethical practice of health care and anesthesiology. Further, we have designed this text around the concepts of safe, effective, efficient, and patient-centered care, and we urge all clinicians to approach their practice with a similar commitment to these principles.

Our goal is to provide the practitioner with a single resource that captures the essence of the full spectrum of anesthesia practice. There are multiple sources of information about anesthesiology, but many ignore the full breadth of the practice. Further, there are numerous focused texts that delve into specific subdisciplines in great detail, often more detail than the trainee or practitioner desires or needs.

In this text, we focus on what is truly important for the clinical practice of anesthesiology in all its dimensions, while being efficient in the presentation of this essential material. Throughout, we have asked: What is important? Why is it important? When should it be applied? and How should it be applied? In brief, we have written for practitioners, not physician scientists. That said, this is not a user's manual of anesthesia care, but rather a text that constantly builds on the concepts of safe, effective (i.e., evidence-based), efficient, and patient-centered care, distilled in a manner that facilitates easy access to the key scientific concepts that underpin high-quality practice. Thus, one finds Key Points and Key References in each chapter, while an extensive reference list is provided online for those who seek in-depth research-based documentation.

Throughout, we embrace an encompassing view of modern anesthesiology practice, underscoring the role of the anesthesiologist as perioperative physician. We emphasize important trends, both in the specialty and in health care in general, to ensure that the reader is not required to go elsewhere for additional information to support the mainstream of their practice. These trends include team-based anesthesia care, the remarkable explosion in pain medicine practice, and the expanded need for practitioners who are skilled in the practice of critical care medicine. No careful observer of the specialty could miss these trends, and no text could be considered "comprehensive" if it did not embrace them as full components of the modern practice of anesthesiology.

Further, we have woven the concepts of quality, safety, cost-effectiveness, and value into the text by emphasizing that perioperative anesthesia care is one system of care within a larger system of care that focuses on overall patient outcomes, not independent events by individual practitioners working in isolated clinical disciplines.

We have approached these and other key "drivers" of contemporary and future anesthesia practice with care, commitment, and enthusiasm for the future of the specialty. We trust that you share this enthusiasm and hope our efforts will serve you well as you continue to translate your knowledge and skills into safe, effective, efficient, and patient-centered care; our patients want nothing less, and our surgical and medical colleagues are looking to anesthesiology to continue to set the example for implementation of these principles. We are honored to serve you through our efforts here.

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PART 1

Introduction to Anesthesiology

CHAPTER 1

Evolution of Anesthesiology as a Clinical Discipline: A Lesson in Developing Professionalism

Raisa D. Nguyen
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KEY POINTS

1. The history of anesthesiology is an interesting and complicated story of professionals seeking to understand the anesthetic state and to safely anesthetize patients.
2. Shortly after the first public demonstration of ether anesthesia on October 16, 1846, by William Thomas Green Morton, the news spread across the world. Initially, anesthetics were administered based on written descriptions in the lay press.
3. London physician John Snow worked out the physics of vaporization of volatile agents by observation of ether and chloroform and used this information to design vaporizers and anesthetic techniques that were safer for the patient.
4. The first professional organization devoted to anesthesia was the London Society of Anaesthetists, founded on May 30, 1893. The first similar group in the United States was the Long Island Society organized by Adolph Frederick Erdmann on October 6, 1905. This eventually became the American Society of Anesthesiologists.
5. Francis Hoffer McMechan organized professional anesthesia in 1912 by helping to create the first national organization, the Associated Anesthetists of America, and went on to found several national and international organizations, of which the International Anesthesia Research Society (IARS) remains active. He was the founding editor of the first journal in the world devoted to the specialty, *Current Researches in Anesthesia and Analgesia,* which is currently published as *Anesthesia and Analgesia*.
6. Ralph Waters is credited with founding the first academic department of anesthesia at the University of Wisconsin in 1927. Much of the current residency structure comes from this seminal department. This helped establish the specialty on an equal footing with other medical specialties.
7. John Lundy at the Mayo Clinic organized the Anaesthetists Travel Club, whose members were the leading young anesthetists of the United States and Canada. These individuals helped create the American Board of Anesthesiology (ABA), which defined what it meant to be an anesthesiologist in the United States.
8. The need for specialists in World War II exposed a large number of young physicians and nurses to anesthetic practice. After the war, physicians returned and helped create the tremendous growth of anesthesiology in the 1950s-1960s, while the nurses greatly expanded nurse anesthesia.
9. In the mid-1950s, the World Federation of Societies of Anesthesiologists (WFSA) was formed, which culminated from a dream that began in the late 1930s. The WFSA made it possible for nations with a long tradition of physician specialization in anesthesia to help train practitioners and introduce the specialty to new countries.
10. In the 1980s, the Anesthesia Patient Safety Foundation (APSF) and the Foundation for Anesthesia Education and Research (FAER) were created. They are additional examples of the professionalism demonstrated by physician leaders throughout anesthesiology's history. These organizations work to create a safe anesthetic environment and to support educational and research efforts in the specialty.

INTRODUCTION

The quest for insensibility to the surgeon's knife is a primordial one. Stretching back to antiquity, physicians have sought ways to render a pain-free surgery. Many different regimens were tried with varying success until October 16, 1846, when surgical anesthesia was publicly demonstrated by William Morton at Massachusetts General Hospital. Yet, there remained a long road to the current operating room full of electronic machines whose sole purpose is to measure the physiologic parameters of the anesthetized patient. How did anesthesiology evolve from a simple glass globe inhaler to the vast array of machines that makes the modern operating room?

The history of anesthesiology is the history of those who have devoted their career to the administration of anesthetics. Without physicians interested in the anesthetic state and the ability to adapt to new conditions demanded of anesthesiologists by surgeons, there would be neither modern surgery nor the specialty of anesthesiology. Many individuals displayed professionalism beyond what was required or expected; others seem reprehensible by "modern" standards. Although many would not consider themselves specialists in anesthesia, their contributions were critical in advancing the specialty. The development of anesthesiology can be told as the history of involved physicians who dedicated themselves to providing safer, more focused care of the patient, first in the operating room and later in the critical care unit and pain clinic. The story begins in ancient Egypt and continues to evolve in untold ways.

PREHISTORY: THE QUEST FOR SURGICAL ANESTHESIA

Imagine for a moment that there is no surgical anesthesia. The Edwin Smith Papyrus describes 48 surgical cases done from 3000 to 2500 BC. Although no specific anesthetic agent is mentioned, within the papyrus there is evidence of compression anesthesia. In one instance, a surgeon compresses the antecubital fossa while operating on the hand; in another instance, the patient compresses his brachial plexus while the surgeon operates on his palm.[1] The ancient Chinese reported the use of an anesthetic for surgery in the 2nd century BC.[2] The use of hemp smoke as an anesthetic was noted in India[3] long before Western medicine developed crude forms of anesthesia.

During the Middle Ages and early Renaissance, a mixture of herbs boiled into a sponge was created to induce anesthesia. At the time of surgery, the sponge was placed in water and the vapors inhaled. Although the vinca alkaloids were a major component of the drugs used in the *spongia somnifera*, the resultant anesthetic was less than satisfactory. Another Renaissance solution was the use of parallel lines of ice placed around the incision. This was effective for simple operations and found use in the Russo-Finnish War of 1939-1940.[4] Alcohol consumed in sufficient quantities was noted to render individuals insensible and was thus used as a standard against which all anesthetics could be measured.[3]

By the 1840s, the effects of nitrous oxide and diethyl ether were already well known. Medical students knew them as intoxicants. In 1800, Humphry Davy described the intoxicating effects in his book, *Researches Chemical and Philosophical: Chiefly Concerning Nitrous Oxide.* Ether, first synthesized in the 1500s, had been observed to lessen the "air hunger" of asthmatics.[5] In January 1842, in Rochester, New York, medical student William E. Clark anesthetized a classmate's sister using ether for a molar extraction. Instructed not to pursue this observation as it most likely was a "hysterical reaction of women," Clarke continued his training and became a respected Chicago area physician.[6]

Two months later in rural Georgia, Dr. Crawford Long, who had hosted parties where ether was used as an intoxicant, used the drug to render James Venable insensitive to the removal of tumors from his neck. Long charged Venable $2 for the anesthetic, thus delineating anesthesia as part of a physician's professional service. In 1844, Hartford, Connecticut, dentist Horace Wells discovered during a show that when an individual was intoxicated by nitrous oxide, pain was abolished. Wells himself underwent a painless tooth removal performed by his partner using nitrous oxide. Soon, he was using "painless dentistry" as part of his professional advertisement. He even attempted to demonstrate a painless tooth extraction at Massachusetts General Hospital in 1844, but although the patient had no memory of the event, it was considered a failure because he groaned during the demonstration.[7]

By the mid-1800s, there were sufficient observations about specific agents that could potentially abolish surgical pain. In rural Jefferson, Georgia, surgery with ether anesthesia was occurring on a limited scale. Yet, Long felt he lacked sufficient cases to study the effects of this new agent.[8] Wells's use of nitrous oxide was groundbreaking, but he lacked the emotional stability to overcome his failed demonstration.[9] Thus, the stage was set for another dentist to demonstrate reproducible surgical anesthesia, giving birth to what would become the specialty of anesthesiology.

DISCOVERY

On October 16, 1846, Morton provided surgical anesthesia for Gilbert Abbott for the removal of a jaw tumor at Massachusetts General Hospital.[10] On completing the operation, surgeon John Collins Warren remarked, "Gentlemen, this is no humbug." The miracle of pain-free surgery so impressed the Boston medical establishment that letters were sent to colleagues across the world. Considerable scholarship has been spent discerning when and where these letters arrived and who first provided anesthesia in each new location. The generally accepted view of the spread of anesthesia to the United Kingdom is a letter from Jacob Bigelow to Francis Boot. However, by careful study of the ships sailing between Boston and Liverpool, another letter, written almost 2 weeks before Bigelow's and only 12 days after the public demonstration of ether, arrived in England on November 1, 1846. Interestingly, this letter was to a patent attorney.[11]

Morton wanted to patent the process of administering ether and wrote to the foremost patent attorney in England to secure rights in the United States and United Kingdom[9] and perhaps the world. He even tried to patent ether itself, calling his anesthetizing mixture "Letheon." However, ether's distinctive odor gave away the true nature of the concoction. The Boston medical establishment had convinced Morton to allow Massachusetts General Hospital to use Letheon free of charge. Unfortunately for Morton, because ether was well known and easy to synthesize and its effects reproducible without "Morton's Inhaler," the patent was unenforceable. He would spend the rest of his life seeking compensation for patent infringement, fighting with the medical establishment into the halls of Congress.[8] Morton clearly was not the embodiment of medical professionalism as we understand it today.

Given the nature of communication in the 1840s, news of Morton's achievement traveled quickly. On December 16, 1846, ether anesthesia arrived in London in the form of a letter. On December 19, the first ether anesthetic was given in the United Kingdom for a tooth extraction. On December 21, the famous surgeon Robert Liston amputated a butler's leg and uttered the words, "This Yankee dodge beats mesmerism hollow." By early 1847, anesthetics were being given across Europe. By June 1847, news had spread to Australia.[12] Peter Parker, minister and physician missionary, on October 4, 1847, gave the first anesthetics in China.[13]

For the history of the specialty of anesthesiology, what is interesting is how willing physicians and dentists were to use ether to induce insensibility. Consider for a moment that outside Boston, no one had actually witnessed surgical anesthesia. Many accounts, especially those reaching South Africa and Australia, were newspaper articles or letters to the editor, often signed by a pseudonym. The hope that these medical professionals had, their desperation to adequately alleviate pain, and their desire to help patients may have been the motivation to try this new technique. Yet, when viewed from the perspective of current early 21st century medicine, this willingness to go on purely written accounts, often in the lay press, without the collaborating voices of the medical profession, seems dangerous and without regard for the basic principle of medicine: first do no harm.

And, what of the surgeons? Surgical pain limited operations to those that could be performed quickly. Anesthesia obviated the need for speed, presenting the possibility of operating within the visceral cavities for hours rather than seconds. But, as the physicians responsible for the patient, long before the specialty of anesthesiology would be defined, we wonder why these professionals were willing to risk lives to find an anesthetic. What does this say to the modern student of medical professionalism?

JOHN SNOW, SPECIALIZATION, AND EARLY PROFESSIONALISM

As reprehensible as Morton's actions appear in patenting his "discovery," Morton was acting within the ethics of his time. The American Medical Association (AMA) was only just beginning. Five months before the public demonstration of ether, the National Medical Convention met for the first time in May 1846 and began to write a code of medical ethics; 1 year later, the code was adopted. Morton's actions were covered under section 4:

> Equally derogatory to professional character is it, for a physician to hold a patent for any surgical instrument, or medicine, or to dispense a secret nostrum, whether it be the composition or exclusive property of himself or others. For, if such nostrum be of real efficacy, any concealment regarding it is inconsistent with beneficence and professional liberality.[14]

Thus, at the time Morton was trying to patent ether and its vaporization apparatus, the medical field was issuing statements against such behavior.

In contrast, London physician John Snow (**Figure 1-1**) began to study the chemical and physical properties of ether and by 1847 had developed a vaporizer. However, unlike Morton, "Snow never patented any

FIGURE 1-1. John Snow. [Used with permission from Wood Library-Museum of Anesthesiology.]

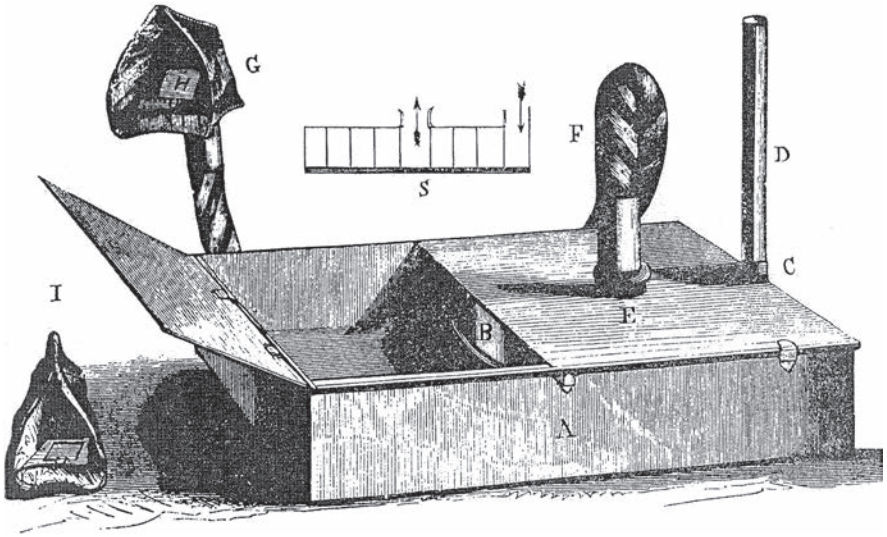


FIGURE 1-2. Snow's vaporizer. [Used with permission from Wood Library-Museum of Anesthesiology.]

apparatus he designed. On the contrary, he published clear descriptions, including engraved figures, so that others could copy them if they chose."[15] By careful observation, he discerned ether's vaporization characteristics. His vaporizer (**Figure 1-2**) was made of coiled copper (**Figure 1-3**), an excellent heat-conducting metal, housed in a water bath to ensure constant temperature of the ether. Thus, Snow was able to calculate the amount of ether a patient would require within a few years of the discovery of anesthesia.[13]

Following the introduction of chloroform as an anesthetic in 1847 by Edinburgh obstetrician James Young Simpson, Snow also began to investigate it. He used his experience with ether as a guide for investigating chloroform's properties. He concluded that it was far safer to give this new anesthetic in measured quantities through an inhaler as opposed to the handkerchief method, whereby chloroform was applied to a cloth and held close to the nose and mouth because the anesthetic depth of the patient could not be adequately controlled. Snow's deliberate nature and strong powers of observation allowed him to create a calibrated, temperature-compensated chloroform vaporizer.[13]

Snow is unique among his London colleagues. In a day when operations were still rarely performed, Snow specialized in anesthetics. In some ways, his expert knowledge allowed him entrée into the upper echelons of both social and physician circles. Perhaps this is best illustrated by his care of Queen Victoria for the birth of her last two children. While Snow did not use his inhaler for the Queen, he also did not induce a full anesthetic state. Rather, he strove for analgesia with chloroform, thus creating a form of obstetrical analgesia, *chloroform a la reine*, which would persist in various forms over the next century.[13]

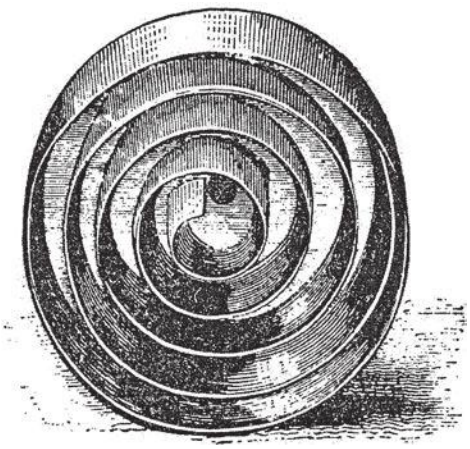


FIGURE 1-3. Coil from Snow's vaporizer. [Used with permission from Wood Library-Museum of Anesthesiology.]

Aside from discerning the physics of vaporization, Snow was intensely interested in outcome data. He studied every report concerning a death under anesthesia and often had data in advance of the published death reports. He commented extensively on Hannah Greener's death, thought to be the first death under anesthesia in the world.[16] In his posthumous book, *On Chloroform and Other Anesthetics*,[17] published in 1858, Snow compiled the first 50 deaths under chloroform with comments about the pathophysiology present. His spirit of inquiry, which extended from benchtop to autopsy, helped him to understand the nature of the anesthetic process and the agents that produced insensibility, thus the scientific underpinnings of a specialty.[18]

A PROFESSION EMERGES

After Snow's untimely death in 1858, anesthesia faded into the medical background. In larger cities, there were those who made a majority of their clinical income from providing anesthesia, yet it would not be until the advent of Listerism and the "taming" of infection that operations would become more frequent. As the number of operations increased, so did the need for anesthesia, and unfortunately, mortality became an issue. Chloroform was responsible for seemingly inexplicable deaths. Ether appeared to be safer, yet its side effects of nausea and vomiting and its prolonged induction compared to chloroform's made it less than ideal. Surgeons began to search for alternative methods for the administration of anesthetics.

In 1884, Carl Koller, an ophthalmology resident in Vienna, was introduced by Sigmund Freud to a new crystalline substance called cocaine. Koller sought a local anesthetic to replace ether anesthesia for eye operations. Because fine suture material to close the eye wound did not yet exist, any postoperative retching could potentially cause vision loss. Therefore, when Koller's tongue became numb from droplets of a solution containing cocaine, he made the conceptual leap that this same solution could be applied to the cornea with similar anesthetic effects. Before long, he had numbed the eyes of several animals, a fellow investigator, and himself. He took this new topical anesthetic to the clinic and used it with great success. On September 15, 1884, Koller's paper on the subject was accepted at the German Ophthalmological Society meeting in Heidelberg. But, because Koller was unable to afford travel expenses, his colleague, Dr. Josef Brettauer, presented the paper for him.[19]

While Koller continued his career in ophthalmology, eventually immigrating to the United States, other physicians modified this new form of anesthesia into an alternative to general narcosis. One of the early practitioners was William Halstead, future chair of surgery at Johns Hopkins University, who was in Vienna at the time of Koller's discovery. Using cocaine topically, Halstead dissected down to a nerve and directly anesthetized it. Much of his work he did on himself, regrettably leading to a cocaine addiction.[20] Another of the pioneers of regional anesthesia was German surgeon Carl Ludwig Schleich, who developed the

technique of infiltration anesthesia.[21] Combining infiltration techniques with the newly discovered lumbar puncture, another academic German surgeon, August Bier, initiated spinal anesthesia in the late 1890s. Working with his fellow, August Hildebrandt, Bier successfully cannulated the subarachnoid space of Hildebrandt and produced a satisfactory anesthetic state. Hildebrandt was unsuccessful in cannulating Bier's subarachnoid space; however, both men suffered postdural-puncture headaches.[22] Ten years later, Bier described an intravenous regional anesthetic technique, which is still known as the Bier block.[23]

At the same time that regional anesthesia was being developed in Germany, concern over the safety of chloroform, especially when compared to ether, was developing. In India, then a colony of England, a Chloroform Commission was seated in Hyderabad in an attempt to determine which anesthetic agent was safest. Funded by the Nizam of Hyderabad, the 1888 study of anesthetic agents was an effort to discover whether there was an intrinsic mortality associated with chloroform. Sadly, the findings were tainted by the British medical officer in charge, Dr. Edward Lawrie, a strong chloroform proponent who trained in chloroform's birthplace of Edinburgh. The findings of the Hyderabad Chloroform Commission were tainted, and a second commission was ordered, which also was inconclusive. Yet, what was important in these commissions is that physicians were studying anesthesia and trying to increase patient safety. For many physicians, it was slowly becoming apparent that there was a need for a specialty practice of anesthesia.[24]

In the early 20th century, the AMA set up a commission to study anesthetics and in 1908 issued a preliminary report.[25] All forms of anesthesia were accounted for, including spinal anesthesia and various combinations of inhalational agents. The conclusions of the report are interesting and foreshadowed the development of a separate specialty:

> All the newer methods demand expertness, experience, and special apparatus. They appeal especially to the surgeons who are equipped with the paraphernalia of expensive and highly specialized clinics. They are little suited to physicians in general practice. For the latter great class of practitioners, the old general anesthetics, chloroform and ether, will probably hold their own until increasing experience has enabled us to simplify and to make safe the newer and more novel methods.[25]

The commission had three interesting recommendations:

1. For the general practitioner and all anesthetists not specially skilled, ether administered by the open-drop method must be the anesthetic of choice.
2. The use of chloroform, particularly for minor operations, is discouraged unless given by an expert.
3. The training of skilled anesthetists is encouraged, and undergraduate students should be more generally instructed in the use of anesthetics.[25]

The last suggestion of the commission took two interesting paths. In many of the operating rooms across the United States, nurses began to administer anesthetics. More reliable than the casual anesthetist, these individuals developed great skill, especially in the administration of open-drop ether. At the Mayo Clinic in Rochester, Minnesota, the nurses were renowned for their skill; physicians and other nurses traveled across the country and the world to observe and learn this skill. Alice Magaw, perhaps the most famous of the early Mayo Clinic nurse anesthetists, published a series of articles at the turn of the century outlining her techniques.[26]

THE RISE OF THE SPECIALIST

The second path, that for the physician specialist, would take the better part of the 20th century. On October 6, 1905, a group of eight physicians and a medical student in Brooklyn, New York, led by Adolph Frederick Erdmann (**Figure 1-4**), gathered to discuss the problem of anesthetics. Like the AMA commission, these young physicians believed that there was more to giving an anesthetic than simply dropping ether on a cloth held near a patient's face and that there needed to be discussions and a free exchange of scientific and practical information.[27] This was the second specialty group in the world that was created, the first being the London Society of Anesthetists in 1893, and it would become the catalyst for the development and recognition of physician specialists in anesthesia.[28] Thus, the Long Island Society of Anesthetists (LISA) was

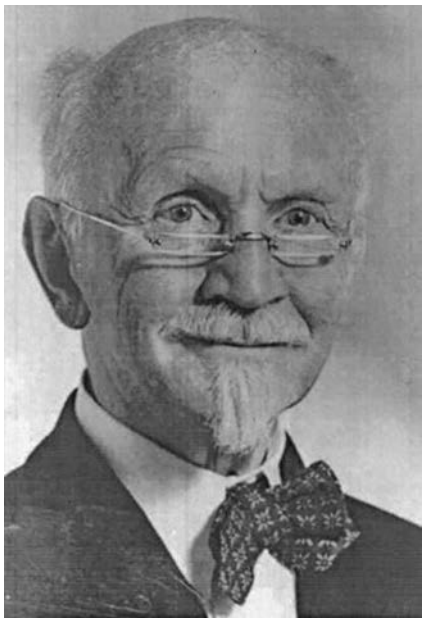


FIGURE 1-4. Adolph Frederick Erdmann. [Used with permission from Wood Library-Museum of Anesthesiology.]

born. The society met quarterly with a short business meeting followed by the presentation of two or three papers and perhaps the demonstration of a new anesthetic technique or apparatus. Science aside, the society provided a "support" group for those seeking to improve their anesthetic skills and a forum to exchange ideas and to deal with problems beyond the science of anesthesia.[27]

The group flourished, and in 1912, it moved to New York City and was renamed the New York Society of Anesthetists (NYSA). By the mid-1920s, the group encompassed the entire state of New York, and by 1936, it had become a national organization.[29] Its transformation focused on the recognition of physicians who primarily anesthetized patients as specialists.

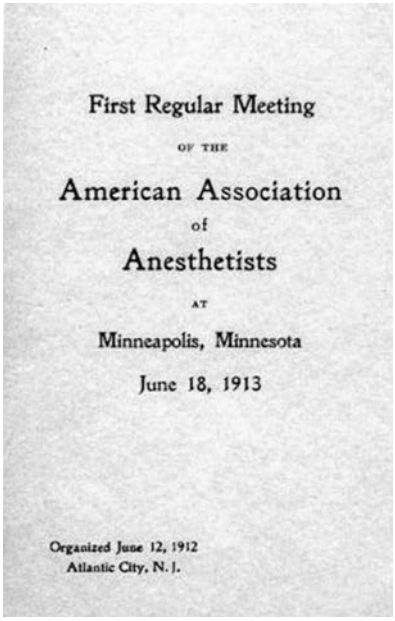
The first significant political move of the NYSA was a motion put before the AMA House of Delegates, asking for a section on anesthetics in 1912. The NYSA was concerned about nonphysicians giving anesthetics and echoed some of the findings of the AMA's Commission on Anesthetics 6 years earlier.[29] James Gwathmey (**Figure 1-5**),

FIGURE 1-5. James Tayloe Gwathmey. [Used with permission from Wood Library-Museum of Anesthesiology.]

FIGURE 1-6. Francis Hoeffer McMechan. [Used with permission from Wood Library-Museum of Anesthesiology.]

the society's president, was developing a new method of anesthesia—rectal ether. Like chloroform, rectal ether could be unpredictable and needed to be administered by someone familiar with its use and with the effects of anesthesia in general.[30] The quest for a section within the AMA was, in some ways, the beginning of a quest for patient safety in anesthesia, a movement that would take the specialty by storm in the late 20th century.

The motion was denied by the AMA House of Delegates, but Gwathmey and Francis Hoeffer McMechan (**Figure 1-6**) gathered the defeated physician anesthetists and created the American Association of Anesthetists (AAA). This was the first national group of physician anesthetists in the United States. They met the following year (1913) for a day of papers, mostly clinical in origin, followed by a dinner with spouses (**Figure 1-7**). A day devoted to the science of anesthesia is memorable;


First Regular Meeting

OF THE

American Association

of

Anesthetists

AT

Minneapolis, Minnesota

June 18, 1913

Organized June 12, 1912
Atlantic City, N. J.

FIGURE 1-7. Program of the first meeting of the American Association of Anesthetists, June 18, 1913, Minneapolis, Minnesota. [Used with permission from Wood Library-Museum of Anesthesiology.]

it signified a group, however small, that was willing to be recognized as specialists in anesthetics, uniting to move the field forward.[29]

The AAA, and its successor, the Associated Anesthetists of the United States and Canada, were run by McMechan. A third-generation physician who entered anesthesia against the advice of his physician father, McMechan developed crippling rheumatoid arthritis and was out of clinical practice by 1911. He was a visionary who desired to see anesthesia "stand shoulder to shoulder" with surgery and internal medicine on a worldwide scale. He realized that without a place to publish papers on the specialty and without a place to gather the news of the various societies and names of physicians practicing anesthesia, the specialty would be doomed. McMehan convinced his friend Joseph McDonald, the editor of the *American Journal of Surgery,* to publish a supplement on anesthesia, giving the physician specialty its first US quarterly. McMechan also edited the *Yearbook of Anesthesia* from 1914 to 1919, compiling all of the papers published in the specialty in the preceding year into a single volume.[31]

McMechan understood that the specialty would never develop as a discipline within medicine without a strong scientific underpinning, so he organized a society devoted to research in anesthesia, first nationally, then internationally in the mid-1920s. The International Anesthesia Research Society (IARS) brought together basic science researchers and the physicians most in need of their talents. Most important, the IARS sponsored the first journal in the world devoted to anesthesiology, *Current Researches in Anesthesia and Analgesia*.[32]

The education of physician specialists, especially in the postgraduate period, was another of McMechan's concerns. Partnering with Ralph Waters, an opportunity emerged at the University of Wisconsin in 1926 as its medical school transformed itself from a 2-year institution offering only basic science education into a 4-year curriculum with all clinical sciences. One addition was a section on anesthesia, headed by Waters, in the department of surgery. Waters immediately began to teach anesthesia to medical students and interns. He collaborated with basic science researchers, first on problems of carbon dioxide absorbance and later on all aspects of anesthesiology through various members of his department. Perhaps most important, Waters established the first residency training program in an academic center, which was 3 years beyond the intern experience. Years 1 and 3 were clinical, while year 2 was devoted to laboratory research. Two weekly conferences were established, one discussing the week's cases in a format similar to current morbidity and mortality conferences and another devoted to current anesthesia literature. By 1933, the teaching program was the envy of the world, and Waters understood that one final step had to be taken. He sent one of his faculty members and an early graduate of the program, Emery Rovenstine, to Bellevue Hospital and New York University to try to replicate the University of Wisconsin department. Rovenstine was successful beyond any expectation, and in some ways, his graduates would eclipse the contributions of Waters's graduates in the development of academic anesthesiology.[33]

In 1929, the Anaesthetists Travel Club was organized by John Lundy at Mayo Clinic. The group was created along the lines of the Society of Clinical Surgery, with members going to other members' institutions to witness their anesthetic practice. The oldest member was Lahey Clinic anesthesiologist Lincoln Sise (55 years old); the youngest members were Philadelphian and future first editor of *Anesthesiology* Henry Ruth (30 years old) and Mayo resident Ralph Tovell (28 years old). These young, influential anesthesiologists were those "standing in line" in the McMechan organization or those who believed that McMechan's international vision of the specialty, while important, would not solve domestic issues. The Travel Club would come to dominate the NYSA and become the nidus of leadership for the effort to create the American Board of Anesthesiology (ABA).[34]

In June 1933, in Milwaukee, Wisconsin, the nurse anesthetists held their first national meeting of the National Association of Nurse Anesthetists. The meeting was notable for a letter of greeting from Everts Graham, MD, then professor of surgery at Washington University in St. Louis and a linchpin in the organization of the ABA some 5 years later. The American Hospital Association was a sponsor of the meeting, and in addition to clinics held at local hospitals, the meeting stressed the importance of a well-organized department of

anesthesiology. It is curious to see many of the same administrative issues that the physician specialists were struggling with were also present at this meeting.[26]

THE CREATION OF THE AMERICAN BOARD OF ANESTHESIOLOGY

The gains in clinical practice in the 1920s and 1930s are best summed up by Harold Griffith, a leading Canadian physician anesthetist; in 1939, he wrote the following:

> Seventeen years ago when I began to give anesthetics, the anesthesia equipment in the small hospital which has ever since been my hospital home, consisted of bottles of ether and chloroform and a few face masks. This was typical of the fairly well-equipped hospitals of that time. Today in that hospital there are eight gas machines of various models, suction equipment in every room, oxygen- and helium-therapy equipment, at least fifteen different anesthetic agents, and much technical equipment for their administration. This transformation has been taking place everywhere in anesthesia.[35]

Economic reasons played a role in the need to define a specialist in anesthesia because physician anesthetists were not well compensated and faced competition from a number of groups. Surgeons, for example, could hire a nurse to help in the office and give anesthetics, while the surgeon charged a fee for both anesthesia and surgery. The income generated from the anesthetic fee was in excess of what he paid the nurse and therefore profitable. Similarly, hospitals could hire nurses to give anesthetics and make an extra profit. Finally, general practitioners would refer cases to surgeons with the caveat that they could give the anesthetic and collect the anesthetic fee for themselves.[36]

McMechan proposed the International College of Anesthetists (ICA) and certified the first fellows in 1935, but there were two serious problems with his certification process. First and foremost, the clinical criteria were weak. The applicant only needed to document 10 anesthetic cases to be eligible. In one instance, an intern rotating on the anesthesia service for 1 month wrote up the necessary cases and became certified. In another, a surgeon who only occasionally gave anesthetics successfully completed the necessary paperwork. Certificate in hand, he attempted to become the head of a hospital division of anesthesia. The second issue with the ICA was that it had no standing with the AMA, meaning the certificate was not "official" in the United States.[37]

Members of the Anaesthetists Travel Club, especially Paul Wood, John Lundy, and Ralph Waters, believed that certification was essential if anesthesiology was going to be recognized as equal to other specialties. Using AMA criteria, which included documentation of either postgraduate training in the specialty or 2500 cases in which the applicant had administered the anesthetic, Wood and his colleagues at the NYSA created a special classification of members called "fellows." This new form of membership was extremely popular, and the NYSA's membership skyrocketed. Now national, the society changed its name to the American Society of Anesthetists in February 1936, and in 1945, they were renamed the American Society of Anesthesiologists (ASA).[38]

Waters, working closely with the chair of surgery at the University of Wisconsin, Erwin Schmidt (**Figure 1-8**), was able to secure an agreement for the ABA to be created as a subboard of the American Board of Surgery. Using AMA criteria, which included the stipulation that the physician must practice the specialty full time, the ABA was created in 1938. The ABA's first written examination, held in March 1939, was in essay format with five subjects: pharmacology, anatomy, physics and chemistry, pathology, and physiology. There was also an oral examination and a practical at the candidate's place of practice.[39]

WORLD WAR II AND BEYOND

The New York World's Fair opened on April 30, 1939, on the eve of World War II. In the Hall of Man, an anesthesiology exhibit (**Figure 1-9**) allowed the general public to learn more about the specialty. The exhibit

FIGURE 1-8. Erwin Schmidt. [Used with permission from Wood Library-Museum of Anesthesiology.]

was paid for by the Winthrope Chemical Company at a cost equivalent to several million dollars today. This proved that anesthesia had enough of a market impact that industry was willing to spend lavishly to support such a display. Second, the clinical practice of anesthesiology had become both complex and commonplace enough that the lay public would recognize and want to learn about it.[40]

At the same time, Lewis Wright was hired by Squibb Pharmaceuticals to investigate new anesthesia drugs, including curare. Wright was a self-taught anesthesiologist who, in midcareer, took a leave of absence from his job at Squibb and did a residency with Emery Rovenstine at Bellevue Hospital.[41] Wright gave some of the first commercially prepared curare to Rovenstine and Emmanuel Papper. However, Papper felt that the agent was a poor anesthetic, as all the test animals stopped breathing when it was administered to them.[42] It was Harold Griffith and Enid Johnson, of Montreal, who discovered curare's true value in anesthesia.[43]

As the United States plunged into World War II, the anesthesia community was determined not to repeat the mistakes of World War I. Physician anesthetists were in short supply and often ran from unit to unit training corpsmen in ether administration by open drop.[44] By the early 1940s, anesthesia had become too complex for this to be successful. The leaders of the ASA worked with the armed forces and developed 90-day courses to train medical officers in the basics of anesthesia. These young physicians managed many horrific clinical situations and were able to decrease mortality.[45] Among these new anesthetists was Samuel Lieberman, who won the Legion of Merit for his work in the South Pacific. By using continuous spinal anesthesia, he decreased the mortality from abdominal wounds from 46% to 12.5%.[46]

Returning from the war, these physicians had tremendous clinical experience, especially with regional anesthesia. Nerve blocks were invaluable because corpsmen could take vital signs and talk to the soldier while the operation was ongoing, freeing the anesthesiologist to treat others. Likewise, these military anesthesiologists had extensive experience with transfusion and fluid therapy. About 40% of them sought additional formal training. Thus, the specialty expanded tremendously, not only because of the returning physicians, but also because their surgeon colleagues demanded physician involvement in anesthesia.[47]

Nurse anesthetists likewise answered the call, creating courses to train nurses as anesthetists. They served with distinction throughout the conflict and would answer the call again and again during all of the US

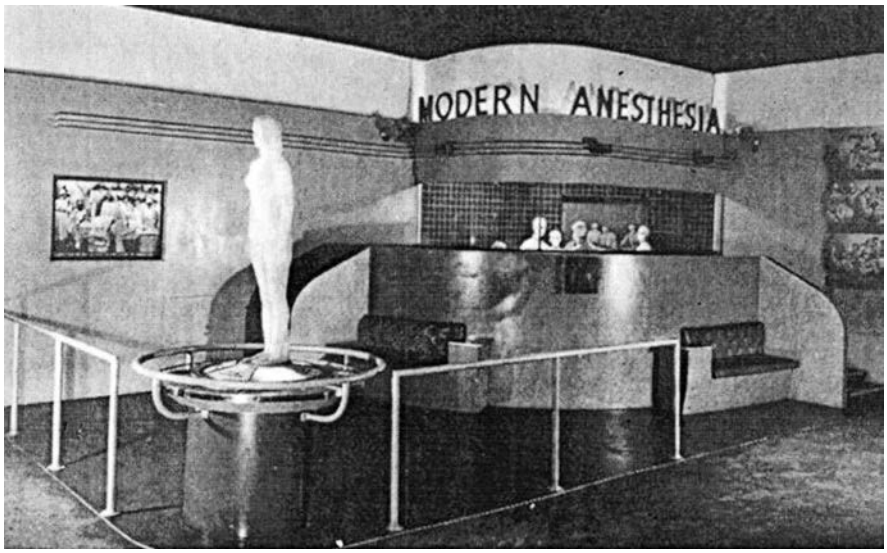


FIGURE 1-9. Postcard image of the anesthesia exhibit at the 1939 World's Fair. [Used with permission from Wood Library-Museum of Anesthesiology.]

armed conflicts. At the end of World War II, the first qualifying exams for nurse anesthetists were administered. During the 1950s, certification of training programs occurred.[26]

THE SECOND HALF OF THE 20TH CENTURY

McMechan's vision of an international community of anesthesiologists came to fruition in the 1950s. The first world meeting of anesthesiologists had been scheduled for Paris in the spring of 1940 but was canceled as the German army invaded. By the early 1950s, Europe was starting to recover from the effects of the war, and the original French organizers were still interested in making the meeting a reality. Working within the European community and Canada and with help from the World Heath Organization, preliminary meetings were organized and the structure of the World Federation of Societies of Anesthesiologists (WFSA) was created. The first World Congress, held at the Hague in the Netherlands in 1955, was a success despite the absence of the ASA. The WFSA wanted to bring the best clinical practice of the specialty to the forefront, and the World Congress was a way to unite anesthesiologists from all walks of life to discuss problems and seek solutions.[47]

Interestingly, the ASA did not join the WFSA until the late 1950s. This reluctance was multifactorial. First, because WFSA dues were on a per capita basis, the ASA felt that they would be providing the majority of the finances of the organization without an equal voice in its government. There was also hesitancy to join an organization that contained communists. Time, dialogue, and the WFSA's performance eliminated those fears.[48]

Along with the international concerns, the specialty faced a challenge in the United States as well. There was a significant part of the anesthesiology community, from the 1940s on, that felt that no physician should accept a contract for services and allow a third party, such as a hospital or other employer, to bill in the physician's name. This edict was enforced by the ASA through the component societies, for an anesthesiologist could not be a member if he or she was not a component society member. Membership was denied if the prospective anesthesiologist was employed under a contract rather than accepting a fee for service. Furthermore, to be eligible to take the ABA examination, an anesthesiologist had to be an ASA member.[49] In response to this, the Association of University Anesthesiologists (AUA) was formed. The majority of academic anesthesiologists were employed by the university for a salary, in violation of the ASA edict. The establishment of the organization is important not only as a protest, but also because it underscores how important academics had become to the fledgling field in the 30 years between the creation of the Waters department to the first AUA meeting.[50] It was a rapid expansion that continued to delineate the scientific underpinnings of the specialty. The AUA was also the first subspecialty society formed in anesthesiology, and it worked to promote scientific research and teaching.

In the 1960s, the US government created the National Institutes of Health (NIH) to support medical research, and Emmanuel Papper (**Figure 1-10**) was invited to Washington, D.C., to help organize it. Dr. Papper worked tirelessly to see that anesthesiologists were treated fairly by the NIH and were eligible for funding. However, he was unable to secure an independent study section for anesthesia, and the battle to obtain this for the specialty remains a leading agenda item for many.[42]

The decade of the 1970s was one of crisis for anesthesiology. To ensure billing that was commensurate with services, the ASA had endorsed a relative value guide that helped place a unit value on work

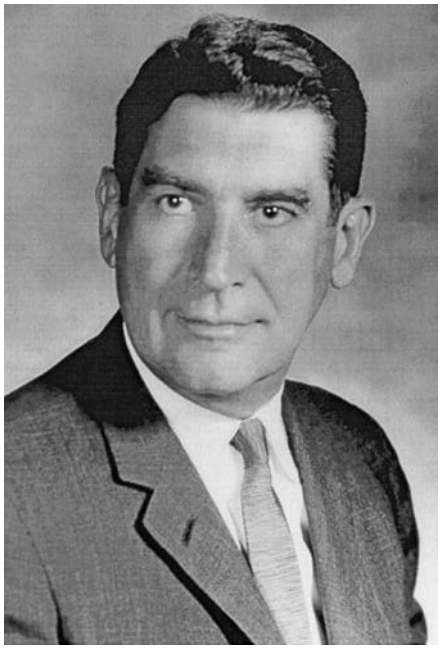


FIGURE 1-10. Emmanuel Papper. [Used with permission from Wood Library-Museum of Anesthesiology.]

done by the physician. Other specialties, including orthopedics and radiology, had adopted similar guides, but the Federal Trade Commission saw this as a monopolistic practice. All other specialties agreed to cease and desist; the ASA instead went to court. After a 2-week trial, the judge ruled that the relative value guide did not represent a monopolistic practice; rather, it was simply a tool that applied monetary value differently in different parts of the country. In one of history's little ironies, 30 years after the verdict, the federal government now considers relative value guides as the preferred billing method. The 1970s also saw another federal government suit against the ASA over fee for service versus an employed model. Thirty years before the legal action, the ASA had adopted a criterion for membership in the 1940s that stated that anesthesiologists would work on a fee-for-service basis similar to internists and surgeons and not as salaried employees of hospitals. In the 1970s, this was viewed by the federal government as restraint of trade, and while there was little chance of a successful suit, both sides agreed to cease and desist, having little desire for another expensive court battle.[51]

The 1970s also saw the beginnings of the anesthesiology subspecialty movement. In 1968, discussions and preliminary meetings were held that led to the formation of the Society for Obstetric Anesthesia and Perinatology. Formed in Kansas City in 1969, the group remains diverse, with anesthesiologists, obstetricians, and perinatologists presenting work of common interest.[52] Likewise in the early 1970s, Maurice Albin and others interested in neuroanesthesia created the Society of Neurosurgical Anesthesia; in 1973, John Mitchenfelder became the first president.[53] In 1975, the American Society of Regional Anesthesia (ASRA) was re-formed, although without knowledge of the prior group formed by Gaston Labat in the 1920s. Publishing the first subspecialty journal, *Regional Anesthesia*, the society provided a place for peer-reviewed scholarly publication in regional anesthesia. Coupled with the annual meeting, the society also provided a forum for anesthesiologists interested in pain medicine. Eventually, the society would change its name to the American Society of Regional Anesthesia and Pain Medicine and that of the journal to *Regional Anesthesia and Pain Medicine*, emphasizing the importance of this emerging field.[54] In the mid-1970s, the Society of Cardiovascular Anesthesiologists emerged, disseminating information about cardiopulmonary bypass and the emerging field of vascular surgery.

The 1980s, by contrast, witnessed the development of two organizations that have served anesthesiology well. The Foundation for Anesthesia Education and Research (FAER) has a special interest in anesthesiologists just beginning their careers and has supported a successful starter grant program. Indeed, many of the leaders of academic anesthesiology in the early 21st century began their careers with a FAER grant. At the same time that the FAER was being formed, the Anesthesia Patient Safety Foundation (APSF) was created to prevent patients from ever being harmed by an anesthetic. The APSF has joined the academic, private practice, and industrial communities to work toward decreasing anesthetic risk. The establishment of the Harvard standards of monitoring, at the beginning of the APSF, was an important step in this direction. The APSF is the model for the patient safety movement across the country and is used by the AMA as a model for its patient safety foundation.[55]

The anesthesiology subspecialty movement continued into the 1980s. In 1987, the first meeting of the Society for Pediatric Anesthesia was held. An outgrowth of the anesthesia section of the American Academy of Pediatrics, the society strove to be inclusive of all anesthesiologists interested in caring for children undergoing anesthesia, not simply anesthesiologists in full-time pediatric practice. Another society formed in the mid-1980s was the Society for Ambulatory Anesthesia.[56] In response to the growing trend of outpatient surgery, the society strives for the highest standards in anesthesia care in the ambulatory setting.[57] Likewise, the American Society of Critical Care Anesthesiologists was formed to establish a forum for anesthesiologists interested in the critical care setting.[58]

During the 1990s, the ABA recognized the trend toward subspecialization by creating special qualifications that could be added to board certification in anesthesiology in both critical care and pain medicine. This trend continues, with added qualifications currently available in palliative care and pediatrics. One of the greatest challenges of modern-day anesthesiology involves the proper role for these additional ABA credentials for general anesthesiologists whose practice also includes the care of children or those in intensive care units or hospices. It remains for practitioners, facilities, the ABA, and the ASA to develop guidelines that support subspecialty care where appropriate without limiting the delivery of anesthesia care in settings where the skills of the general anesthesiologist are commensurate with the challenge (not unlike the challenges in all of medicine relative to primary vs specialty care in the 21st century).

INTRODUCTION OF THE ANESTHESIA ASSISTANT

In the 1960s, yet another shortage of anesthesia providers led to the beginning of the anesthesiology assistant (AA) profession. After studying the educational pathway for anesthesiologists and nurse anesthetists, they created a new educational paradigm for a midlevel anesthesia practitioner that included a premedical background in college. This person would perform the same role as the nurse anesthetists but would be readily able to go on to medical school if appropriate.

The concept became reality in 1969 when the first AA training program began accepting students at Emory University in Atlanta, Georgia, followed shortly thereafter by a second program at Case Western Reserve University in Cleveland, Ohio. Since that time, the number of practicing AAs and their educational programs has grown steadily.[59]

Despite also being midlevel providers with similar job descriptions, AAs differ slightly from nurse anesthetists. Rather than having a nursing educational background, AAs require a science/premedical background that would theoretically allow them to enter medical school more easily than nurse anesthetists if, in the future, they so desired.[60]

CONCLUSIONS

By comparison with most other medical specialties, the history of clinical anesthesia is short. Perhaps Francis Hoeffer McMechan summed it best when in 1935 he wrote the following:

> Anesthesia was the gift of pioneer doctors and dentists to suffering humanity, and every significant advance in its science and practice has been contributed by doctors, dentists, and research workers of similar standing. In contrast, technicians have added nothing of any consequence. Anesthetics are among the most potent and dangerous drugs used in the practice of medicine; they penetrate to every cell and organ of the body and may cause almost instant or delayed death by their toxic effects. The dosage of general inhalation anesthetics cannot be prescribed in advance but must be determined from moment to moment during administration. The dosage of local and other anesthetics must be determined by the risk of the patient, the nature and duration of the operation to be done—certainly a challenge to the knowledge and experience of the keenest doctor. No patient should ever be given an anesthetic whose condition and risk has not been diagnosed in advance of the operation, so that every resource of medical science can be used to lessen the risk and make the recovery more assuring. Certainly in this preoperative evaluation and the selection of the safest anesthetic and best method of administration, the medical anesthetist is more in a position to act as a consultant than a technician. …
>
> The safety of the patient demands that the anesthetist be able to treat every complication that may arise from the anesthetic itself by the use of methods of treatment that may be indicated. The medical anesthetist can do this, the technician cannot. More recent developments have extended the field of medical anesthesia to include resuscitation, oxygen therapy, and therapeutic nerve block for intractable pain, and treatment of various conditions of disease, and the rehabilitation of the disabled—all fields of practice quite beyond the capacity of the technician."[61]

McMechan's vision of professionalism, and its 21st century equivalents, needs to continue to guide the specialty. The history of anesthesia is interesting, filled with fascinating events and people, and is replete with the highest examples of professionalism—the best is yet to come.

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Complete references are available online at www.LongneckerAnesthesiology.com.

CHAPTER 2

The Scope and Future of Anesthesia Practice

Tess Murray
Michael S. Avidan
Alex S. Evers

KEY POINTS

1. The operating room remains the primary focus for the vast majority of practitioners.
2. The practitioner's primary responsibility is to ensure patients' comfort and safety when they are exposed to the trespass of surgery and other invasive procedures.
3. The intraoperative conduct of anesthesia has both immediate and long-term effects on patient safety and outcomes postoperatively.
4. The provision of safe anesthetic care across geographically dispersed sites and encompassing wide ranges of patient health, in an economically responsible manner, is a challenge that anesthesiologists need to address proactively.
5. The personal administration of every anesthetic is not feasible due to workforce limitations; team-based anesthesia care is required to meet the demand for anesthesia services.
6. Meeting the personnel, safety, and cost demands of the future will require that providers overcome the political infighting between organized anesthesiology and nurse anesthesia, especially in an era when the majority of these individual providers work together effectively.
7. Many believe it is important for the future of the specialty that anesthesiologists assume a broader role in perioperative medicine.
8. Advances in knowledge and technology have created an opportunity for anesthesiologists to address the scientific questions at the core of the specialty as well as a variety of important clinical problems.
9. Future opportunities for anesthesiologists include greater involvement in pharmacogenomics, business, and health care systems management and the development of new technologies, while continuing to lead and develop traditional areas, such as operating room anesthesia, critical care, pain medicine, teaching, research, and resuscitation.

Anesthesiology arose as a medical specialty because the dangers associated with anesthetic drugs and techniques demanded administration by skilled and knowledgeable physicians. As safer drugs were developed and physiologic monitoring improved, the need for anesthesiologists was propelled by increasing surgical complexity and severity of patient illness, as well as by increasing expectations for patient safety. Whereas the original raison d'être for the specialty remains today, a variety of professional and economic factors have challenged anesthesiology and produced large "swings of fortune" during the past few decades.

During the 1970s and 1980s, the emergence of critical care attracted many talented medical students to American anesthesiology training programs. However, these were halcyon days for anesthesiologists practicing in the operating room, where professional income was high, job opportunities were ample, and increasing surgical complexity demanded an increasing level of medical knowledge and skills. Thus, there was little incentive for anesthesiologists to expand their roles beyond the confines of the operating suites, and many trainees who were initially attracted by critical care subsequently practiced operating room anesthesia only. In contrast, anesthesiologists in Europe and Canada were expanding their roles during this same period in the burgeoning subspecialties of pain, intensive care, and resuscitation.

In the mid-1990s, gloom beset anesthesiology in the United States as predictions, widely reported in lay press such as the *Wall Street Journal*, suggested that the need for anesthesiologists would decrease dramatically in an anticipated managed care environment. Medical graduates were discouraged from pursuing careers in anesthesiology, and residency programs contracted dramatically. But, these predictions were wildly inaccurate. In the last 10 years, US anesthesiology programs have enjoyed a revival, and many talented medical graduates have chosen to enter the specialty.[1] Another encouraging recent trend has been the marked increased in the proportion of US finishing residents who are choosing to pursue fellowships to bolster their specialist knowledge and refine their clinical skills. All of the traditional anesthesiology subspecialties (eg, pain medicine, critical care, pediatrics, clinical scientist) are benefiting from this growing cadre of subspecialists, and new subspecialties are on the rise (eg, sleep medicine and health care administration). Anesthesiologists in other parts of the world have also experienced fluctuating fortunes.

The future of anesthesiology depends on several factors, including changes in surgical and interventional practice, technological advances in anesthesiology, the evolving scope of anesthesia practice, and the role of nonphysicians (eg, nurse anesthetists and anesthesia physician assistants), and physicians trained in other specialties, in the provision of anesthesia care. The evolution of health care financing and the consolidation of private practice groups into large regional and national multispecialty consortia will also continue to influence trends in anesthesia practice. This chapter reviews briefly the current scope of anesthetic practice and offers some possible scenarios for future directions of the specialty.

OPERATING ROOM ANESTHESIA

The operating room remains the primary focus for the vast majority of anesthesiologists. The anesthesiologist's primary responsibility in this arena is to ensure patients' comfort and safety when they are exposed to the trespass of surgery; this includes protecting the patient from pain, undesired awareness, and organ system injury and fostering full recovery from the surgical and anesthetic interventions (not simply the emergence from anesthesia). Over the past decades, it has become increasingly clear that the intraoperative conduct of anesthesia has profound effects on patient safety, surgical outcomes, and comfort in the postoperative period. For example, modest intraoperative hypothermia can either increase the incidence of wound infection[2] or provide neuroprotection,[3] depending on the clinical situation. Some studies have also shown an influence by anesthetic management on broader outcomes,[4] including surgical mortality[5] and even recurrence of certain cancers.[6]

Anesthesiologists are increasingly sophisticated in their understanding of patient safety, and they are focusing on such issues as appropriate perioperative medications, antibiotic prophylaxis and infection control, multimodal analgesia, maintenance of normothermia and normoglycemia, and appropriate fluid and electrolyte therapy. A recent observational study demonstrated an almost 2-fold increase in coronary artery bypass graft surgical mortality in "low-performance" anesthesiologists compared to "high-performance" anesthesiologists, highlighting the possible impact that individual providers can have on patient outcomes. A growing responsibility for overall postoperative outcomes raises new expectations for knowledge and skills of the practicing anesthesiologist and challenges our previously narrower definitions of anesthetic outcome.[7]

Despite the demands imposed by increasing severity of illness in surgical patients, growing surgical complexity, and more comprehensive postoperative considerations, anesthesiology is often viewed as a victim of its own perceived success. The widely cited study from the United Kingdom in the 1980s, the Confidential Enquiry Into Perioperative Deaths (CEPOD), reported that patients undergoing general anesthesia have a 1 in 185,000 chance of dying as a consequence of anesthetic misadventure,[8-10] a finding highlighted in the Institute of Medicine report on medical errors[11] that cited anesthesiology as the specialty that had best addressed safety issues (see Chapters 3, 21, and 22 for more comprehensive reviews of quality and safety in anesthesia practice). More recent studies have confirmed low anesthesia-attributable mortality rates in developed countries, ranging from less than 1 in 10:000[12] to 1 in 40,000 or 1 in 120,000 cases.[13] However, developing countries continue to have mortality rates that are an order of magnitude greater (141 events per million anesthetics in developing countries vs 25 events per million in developed countries).[14] Despite the accepted improvements in perioperative mortality, the exact rate may be greater than recently reported. Further, the reported mortality rates vary significantly due to differences in definitions and reporting sources.[15]

As a result of the major improvements in anesthesia-attributable mortality over the last several decades, the perception of anesthesia as "safe" has encouraged nonphysician anesthesia clinicians to advocate for independent practice, with over a dozen US states choosing to opt out of mandatory physician supervision. It has also suggested to insurers that anesthesia care by a physician anesthesiologist is needlessly expensive. While some studies have suggested that rates of mortality associated with anesthesia are actually higher than those publicized,[15] the fact remains that the field has made significant strides in reducing these rates. However, as Ronald Miller warned in his 2009 Rovenstine lecture, anesthesiologists cannot "content ourselves with the fact that few patients experience intraoperative death due solely to anesthetic mishap."[16] Overall surgical mortality remains as high as 4% in the week following surgery,[17] and almost 40% of in-hospital adverse events are related to surgical operations.[18] Many problems in perioperative safety remain to be addressed, and anesthesiologists must be willing to share responsibility with our surgical colleagues for a broader range of outcomes to truly be co-equal partners in the evolution of twenty-first-century health care systems.[19]

Challenges to anesthesiology are exacerbated by the massive expansion in demand for anesthesia services for a variety of nonoperative procedures, ranging from cerebral aneurysm coiling to pediatric sedation for procedures[20] and general anesthesia for screening colonoscopy. The introduction of free-standing ambulatory surgery centers and office-based surgical suites where anesthesia is administered raises other concerns. The demands for safe anesthesia care provided in numerous remote locations with a wide range of severity of patient illnesses present significant challenges to the workforce, financing, and practice of anesthesiology that anesthesiologists need to address proactively.

Current practice models vary widely in both the United States and worldwide. In the United States, some anesthesiologists (or practice groups) personally provide all anesthetic care regardless of complexity, an approach that is also common in the United Kingdom, Canada, and Australia. In other practices, anesthesiologists supervise other clinicians (eg, nurse anesthetists, residents, or anesthesia assistants) in more than one operating room, a practice model found in many European countries, including the Netherlands, France, Denmark, Switzerland, and Norway. Currently, at least 50% of anesthesia care in the United States involves nurse anesthetists, and anesthesia practice worldwide often includes some form of nonphysician clinician or physician who is not a fully trained anesthesiologist. Some reports asserted that nonanesthesiologists can safely provide anesthesia for selected procedures (eg, colonoscopy) and patients,[21] and that nurse anesthetists perform no worse than trained anesthesiologists in simulated patient emergencies[22] (see Chapter 21 for an in-depth discussion of risk in anesthesia, including an assessment of the validity of several of the practice pattern comparisons). It is also clear that patients with minimal physiological reserve, those undergoing major interventions, and those with complex medical problems likely require the direct involvement of a skilled anesthesiologist to enhance patient safety.[23,24] Unfortunately, too often practitioner skill and experience are not matched to these factors but determined by availability of clinicians or the use of a fixed model of care delivery, rather than one that is tailored to the specific clinical situation. This is a fruitful area for further health services research by anesthesiologists to ensure proper matching of resources to the clinical needs.

The expectations for operating room anesthesia can be simply stated: *We need to provide an ever-increasing quality of perioperative care at a lower cost.* In turn, these expectations and predictions require that the anesthesiology community consider who will, or should, provide each component of anesthesia care; what levels of knowledge and skill will be required of each clinician; and how the responsibility for care will be organized, managed, and rewarded. It is arithmetically impossible to provide a fully trained individual anesthesiologist for every anesthetic procedure.[25] Further, the increasing demands for anesthesia services (aging population, proliferation of ambulatory surgery centers, escalating demand for nonsurgical anesthesia and sedation) will outstrip even the most aggressive output of anesthesiologists. Medical schools simply would not have the capacity to provide sufficient graduates to populate a large increase in the number of anesthesiology residents, and the current economic environment does not have the resources to sustain such an expansion.

For reasons of both anesthesiologist availability and cost, it is thus apparent that the future of anesthesia practice will involve an increasing role for nonphysician clinicians. How can this be made compatible with the demands for increasing safety and quality? This can be accomplished by involving skilled anesthesiologists in the cognitive aspects of *every* anesthetic. This will require coordination and cooperation with nonphysician clinicians, allowing them to perform at the highest levels compatible with their training, knowledge, and experience, while ensuring that a fully trained specialist is involved in planning and managing care for high-risk cases and is readily available for complex diagnostic and therapeutic decision-making.

Technological developments in monitoring and information systems should facilitate these changes. The development and expansion of telemedicine in critical care units, and the demonstration of resulting improved patient outcomes,[26-28] provide one model of care that could be feasible even in communities where an anesthesiologist is not physically present.[29]

Meeting the personnel, safety, and cost demands of the future will require that providers overcome the political infighting between organized anesthesiology and nurse anesthesia, especially in an era when the majority of these individual providers work together effectively Further,

the training of anesthesiologists will increasingly need to encompass the development of skills in managing team-based care when working with other anesthesia clinicians. It is in the interests of public safety and health care delivery that unity be forged among anesthesia clinicians under the leadership of specialist anesthesiologists, whose medical training and education are required for complex medical decision-making, supplemented by the skills and abilities of nonphysician clinicians who further enhance this team approach.

OUTSIDE THE OPERATING ROOM

PREOPERATIVE CARE

Perioperative morbidity is frequently attributable to poor preoperative patient assessment and preparation. These roles have always been integral to the anesthesiologist's practice. However, as patients increasingly present to the hospital on the day of service, it has become necessary to ensure that patients are properly evaluated well before the immediate preoperative interval. Recognizing this need has led to burgeoning preoperative assessment clinics, where problems such as ischemic heart disease, pulmonary disease, or sleep apnea may be evaluated and appropriate perioperative interventions may be planned (see Chapter 5 for a detailed discussion of the benefits and operation of preoperative clinics). In some practice settings, preoperative assessment of complicated patients has been largely relegated to nonanesthesiology trained physicians or physician extenders. In other settings, the challenge of same-day surgery admission has left preoperative assessment as a day-of-surgery activity; neither of these approaches is uniformly optimal. Almost all models for the future practice of anesthesia include greater involvement of anesthesiologists in the continuum of patient care and thus a greater role in patient outcomes. From this standpoint, it is essential that anesthesiologists continue to play an integral role in preoperative assessment clinics. This should also be a key component of anesthesia resident training programs, for it represents an important aspect of patient safety and the future anesthesia practice.

PAIN MEDICINE

Doctors cannot always cure disease, but they should always try to alleviate suffering. Physical pain is among the most unpleasant of human experiences. Anesthesiologists are often involved in the management of severe pain associated with surgery, and the perioperative use of analgesics constitutes an important component of anesthetic care. Anesthesiologists are more comfortable with opiate administration than many other physicians, because of both their knowledge of pharmacology (especially opioid pharmacology) and their skill and experience in managing side effects, such as respiratory depression. Anesthesiologists have pioneered regional anesthetic techniques, many of which are applicable to the treatment of chronic intractable pain. Increasing numbers of anesthesiologists are specializing in pain management, and the effective relief of pain will remain an important component of the anesthesiologist's role even for those who do not subspecialize specifically in pain medicine.

CRITICAL CARE MEDICINE

Anesthesiologists pioneered the development of critical care medicine,[30] and in many countries outside the United States, anesthesiologists constitute the bulk of the physician workforce in critical care. In most of Europe, full training in critical care is an integral component of an anesthesia residency, and critical care anesthesiologists are responsible for organizing and staffing most hospital critical care units. In contrast, US anesthesia residents receive only a few months of critical care training, and anesthesiologists constitute a minority of the nation's critical care physicians. Many believe that part of the future of the specialty will be an increased commitment of anesthesiologists to critical care medicine. To achieve this, leading academic programs must expand their critical care fellowships and promote critical care as a financially viable and intellectually rewarding subspecialty for talented graduating residents.

CLINICAL SERVICES ADMINISTRATION

The operating suite is a complex environment, one that often has not been efficiently managed. Anesthesiologists are an integral component of this important but unwieldy organization. The need for effective management and administration is being increasingly recognized, and anesthesiologists are often sought for this management function. In many countries, including in Europe and North America, anesthesiologists are acquiring formal training in health care management and business administration. Today's doctors, even in academic institutions and national health services, cannot afford to isolate themselves from the realities of reimbursement, cost, efficiency, patient satisfaction, and overall system performance, and there appears to be a bright future for physician leaders in health care organizations. Anesthesiologists are, and will continue to be, an important part of this management evolution.

PATIENT SAFETY

Anesthesiologists have been at the forefront of pioneering patient safety. The improvements have been so dramatic that liability insurance for anesthesia practice continues to decrease while that for most other specialties has steadily increased (some dramatically). The Anesthesia Patient Safety Foundation (APSF) was founded in the United States in 1984 with the expressed purpose of ensuring "that no patient shall be harmed by the effects of anesthesia." Since 1985, the Committee on Professional Liability of the American Society of Anesthesiologists (ASA) has been studying records of closed malpractice claim files for anesthesia-related patient injuries.[31] Over 10,000 claims have been studied. Similar safety foundations and incident review boards have been established in many other countries; in 1987, the Australian Patient Safety Foundation was established,[32] and the national CEPOD was started in the United Kingdom in 1989. Analysis of critical incidents has reinforced the value of physiologic monitoring in improving patient safety. The results also confirmed the value of structured algorithms in anesthesia care by documenting favorable outcomes in a range of life-threatening crises during anesthesia. Changes in consultant practice, increased medical audits, appropriate matching of specialist experience to patients' medical conditions, and increased awareness of the need for critical care services have all been affected through these inquiries.[33]

Critical events occur within the context of complex system failures, and anesthesiologists have developed safeguards to decrease the likelihood that human error may result in patient harm. Examples include audible alarm settings and automated anesthesia machine checks, the pin index safety system, and written "checklists." A seminal study showed how the routine implementation in hospitals around the world of a simple 19-item surgical safety checklist designed to improve team communication and consistency of care markedly reduced 30-day complications (from 11% to 7%) and deaths (from 1.5% to 0.8%) associated with surgery.[34] Expertise in patient safety should be developed and translated into the broader medical context, including application in areas not historically viewed as the purview of anesthesia practice (such as diagnostic and treatment suites, obstetrical suites, intensive care units, and intermediate care units).

RESEARCH

Anesthesiology has a vibrant history of research and intellectual contributions to clinical medicine. Historically, anesthesia research has focused on laboratory investigations in physiology and pharmacology and their application to patient care. These contributions have improved the safety of anesthesia and surgery and constituted pioneering efforts in the initial application of scientific principles to individual patient care. Previously, many of the scientific questions at the core of anesthesiology were relatively inaccessible to investigation; this stemmed from the absence of tools to study the mechanisms of the complex behaviors (eg, consciousness, memory, pain) that anesthesiologists manipulate. Advances in cellular physiology, molecular biology, genetics, functional imaging, and behavioral sciences, and the application of advanced statistical and mathematical models, have enabled serious investigation of

these behaviors. It is thus now possible that the fundamental mysteries of anesthesia (including the molecular mechanism of the hypnotic, amnestic, and analgesic effects of anesthetics agents) will be solved. These same scientific tools also make it feasible to define the mechanisms of hyperalgesia and chronic pain and to design more effective treatments. Finally, advances in the understanding and manipulation of inflammation and the immune response provide a new opportunity to delineate how organ system injury occurs in the perioperative period and how to detect it and to identify strategies for protection of the brain, heart, kidneys, and other organs. Collectively, recent advances in knowledge and technology create an enormous opportunity for anesthesiology to address the scientific questions at the core of the specialty, as well as a variety of important clinical problems. Innovative anesthesiology training programs are offering integrated scholarship tracks to the most academically competitive residency applicants, and several programs are offering fellowships in clinical and translational research.

The application of information technology and epidemiologic techniques (often referred to as outcomes research) to the perioperative period has also created new research opportunities for anesthesiology. These approaches quantify and describe perioperative morbidity and mortality and have facilitated recognition of patterns and causes of adverse patient outcomes. Recognizing the need for detailed perioperative clinical data, the ASA established the Anesthesia Quality Institute in 2008. The institute houses the National Anesthesia Clinical Outcomes Registry, a recognized patient data registry containing more than 22 million surgical cases[35] and the anesthesia-specific data elements that are essential for comprehensive perioperative clinical research.[36,37] The registry is combined with other data sources to enable clinician benchmarking, quality improvement, research, public reporting, credentialing, and maintenance of certification.

Academic anesthesia has been challenged at times over the years, with decreased academic funding of some departments and a decreasing share of extramural grant funds.[38] One reason put forward for reduced funding for anesthesia research is that the current safety of anesthesia implies that anesthesia research is not a pressing public health concern. As noted, this may be a misconception; while intraoperative mortality is rare, postoperative mortality and major morbidity still occur commonly, and anesthesia care has been shown to contribute to this process, both positively and negatively. There is much room for improvement before any field can conclude that we have overcome the hurdles in surgical care that challenge the extremes of age, those with significant comorbidities, or those undergoing extensive surgical procedures. Many of the advances in these areas will come from improved perioperative care, built on evidence-based techniques that are confirmed by careful clinical investigation and innovation. The National Institutes of Health continue to prioritize multidisciplinary and multicenter research initiatives along with translational research, where advances in the basic sciences, including genetics, can lead to progress in the clinical arena. A strong commitment to research will be necessary to ensure the continued advance of the specialty and ensure that anesthesiology remains a mainstream medical discipline that contributes to the overall good of society.

EDUCATION AND TRAINING

Clearly, the future of the specialty requires a robust commitment to education and training at all levels, from undergraduate medical education through the most advanced subspecialty levels. Strong training programs depend on an excellent teaching faculty, ample and diverse clinical cases, a well-organized teaching program, and an emphasis on the knowledge required for future as well as current practice. Adequate funding for anesthesiology education by the federal government, by teaching hospitals, and by our specialty societies is imperative if the specialty is to flourish in future decades. Many of the models for the future practice of anesthesia include an expansion of the scope of residency and fellowship training,[39] and some envision a drastic reorganization of the education process.[40] It is clear that the next generation of anesthesiologists must be skilled in preoperative assessment, critical care, pain management, supervision of nonphysician clinicians, and operating room administration. There must also be continued emphasis on fellowship programs, with formal recognition of fellowships in areas such as regional anesthesia, transplant anesthesia, and obstetric anesthesia, and the expansion of new fellowships in health care management and business administration.

To attract high-caliber applicants to anesthesiology, it is important that medical students continue to receive adequate exposure to the specialty. In addition to perioperative medicine and pain medicine, anesthesiologists are well placed to teach medical students applied respiratory and cardiovascular physiology, several aspects of neuroscience, and numerous aspects of pharmacology, in addition to their more traditional educational roles in resuscitation and emergency airway management. The model of academic anesthesia care facilitates excellent learning, with medical students able to spend high-quality one-on-one time with experienced anesthesiologists.

SIMULATION

The aerospace industry has long appreciated the value of simulation in increasing safety and decreasing errors. Within the medical profession, anesthesiologists have been among the first to recognize the potential role of simulation in improving both education and patient safety. Anesthesiologists established the validity of simulation facilities[41] in training anesthesiologists in the management of infrequent but life-threatening problems that arise in the operating room. It has become apparent that simulation is useful for teaching other topics that are not unique to anesthesia practice (eg, diagnosis and management of pneumothorax, hemorrhagic shock, myocardial infarction, insertion of central vascular catheters). Increasingly, physician and nursing professionals, including those in critical care and emergency medicine, are seeking time in simulation facilities for purposes of training and honing their skills in crisis management. Simulation centers are mushrooming internationally and are also being embraced by medical schools. Anesthesiologists have led this initiative, and it is important that we continue to lead innovation in this evolving field of technology. Maintenance of certification is increasingly emphasized for specialist medical practice and is particularly valued by the public.[42] Simulation offers a practical method to assess anesthesiologists and other practicing clinicians, and it is being used in both initial certification and maintenance of certification programs.[43-45]

PUBLIC PERCEPTION OF ANESTHESIOLOGISTS

Anesthesiology is one of the largest physician-based specialties, but few mainstream medical specialties are as poorly understood by members of the public and by other health professionals.[46] Many patients do not realize that anesthesiologists are doctors, and fewer understand that they have responsibilities outside the operating room.[46] Even a high level of health literacy is not associated with better understanding of the role of anesthesiologists, as demonstrated by a recent study performed at the Mayo Clinic.[47] In studies from Saudi Arabia, Singapore, Pakistan, and the West Indies, only 55% to 66% of patients were aware that anesthesiologists are physicians, and most patients had a limited knowledge of the anesthesiologists' roles.[48-51] A few studies from Europe have reported high levels of recognition of anesthesiologists as specialist physicians[52]; at the same time, many patients also thought that the anesthesiologists played a subservient role to the surgical team,[53,54] and the majority of studies do not demonstrate such a high level of awareness.[55] In response to these deficits, many anesthesia societies around the world are recognizing and celebrating World Anesthesia Day on October 16 to commemorate the anniversary of the first ether anesthetic at Massachusetts General Hospital in Boston. This work to heighten awareness and improve the perception of anesthesiologists and their essential functions among the general population and other physician societies may be important to the future of the specialty in several respects, including allocation of research funding, quality of applicants to residencies, and the future role of anesthesiologists within health care in general.

A Scandinavian study explored perceptions of the anesthesiologist's role: "Professional Artist, Good Samaritan, Servant and Co-coordinator: Four Ways of Understanding the Anaesthetist's Work."[56] According to

these authors, the current scope of anesthesia practice encompasses the following:

1. The provision of safe anesthesia while controlling patients' vital functions.
2. Helping patients, including the alleviation of pain and anxiety.
3. Providing service to the whole hospital, including support to other doctors and nurses who are caring for severely ill patients.
4. Participation in the organization and direction of the operating suites to ensure that schedules run smoothly.

Whereas these are essential and important components of the specialty, even collectively they do not encompass the spectrum of anesthesiology as we view it currently, or as we look to the future, which seems particularly attractive if we maintain a comprehensive view of the opportunities for our discipline.

THE FUTURE OF ANESTHESIA PRACTICE AND EDUCATION

The future of the specialty depends on several key drivers: (1) the vision and actions of organized anesthesiology; (2) technological changes in surgery and anesthesiology; (3) the changing demographics of the US population, which is skewing toward the elderly; and (4) the directions chosen by residency programs, the principal trainers of future anesthesiologists. Economic forces—including in the United States the expansion of alternative risk-based payment models such as accountable care organizations, bundled care payments and value-based purchasing, the Patient Protection and Affordable Care Act of 2010, and the consolidation of anesthesia practices into regional and national multispecialty groups—cannot be ignored. These drivers will influence the attractiveness of anesthesiology as a specialty choice for medical students, the career paths of young anesthesiologists, and the scope and organization of anesthetic practice.

Future anesthesiologists will face challenging choices. New drugs and increasingly sophisticated monitoring continue to facilitate safer anesthesia. Such technological advances will allow more effective remote supervision of anesthesia clinicians. There will be steady growth in the demand for anesthesia services both within and beyond the operating suites. Anesthesiology training programs will have to decide whether to expand their ranks to meet current service needs or whether to refine their training and practice models according to anticipated future conditions. It is highly unlikely that anesthesiologists alone will be able to meet all the demands for anesthesia services, especially as the specialty continues to expand into areas such as critical care medicine and pain medicine.

To meet future challenges, many foresee the expansion of perioperative medicine, which includes the spectrum of care from preoperative assessment to postoperative care, as the best opportunity for the specialty to thrive, prosper, and address future health needs of the population.[39,40,57-60] While there is a vision that future anesthesiologists will practice as much outside as inside operating rooms,[61] the expansion of anesthesiologists' activities could lead to dilution of the specialty's identity, endangering the vitality of anesthesiology in an era of sweeping changes in health care delivery systems.[62] There are examples of this in other disciplines, such as internal medicine, where the move to subspecialization has plundered the ranks of primary care internists, for example. Further, an expansion of anesthesiology practice into nonoperative domains of perioperative medicine may also be challenged by other specialties that seek similar roles. Anesthesiology may thrive and expand its reach, or it may have its subspecialties amputated, leaving it as a restricted specialty bound to the operating room (**Figure 2-1**).

As an academic specialty, anesthesiology evolved from fundamental contributions to health care, including the prevention of pain from surgery and the development of critical care medicine, cardiopulmonary resuscitation, and pain medicine.[63] In recent years, many advances have occurred in the basic science of anesthesiology; these involve mechanisms of pain, receptor physiology, modes of action of anesthetic agents, and cellular responses to sepsis, for example. If anesthesiology is to flourish as an academic specialty, it is crucial that research is pursued

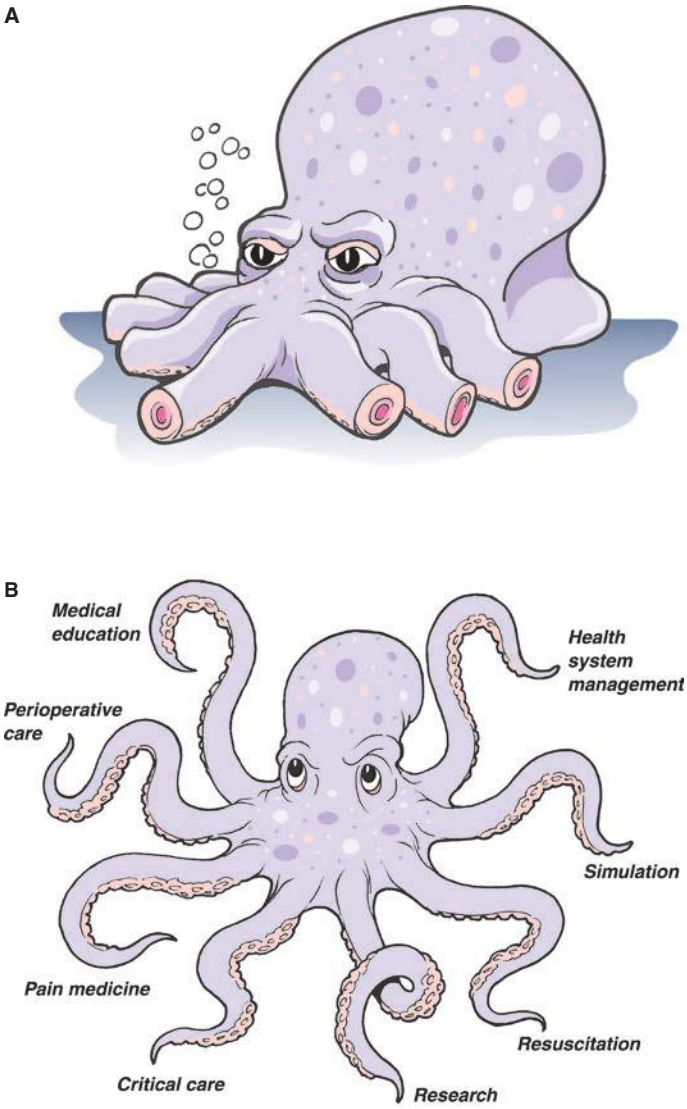

FIGURE 2-1. The future of anesthesiology: two possible outcomes. **A.** The specialty may come to resemble a bloated octopus, based only in the operating room with all its tentacles amputated. **B.** Anesthesiology may retain its integral role in the operating room but expand its tentacles in other areas, such as critical care, pain medicine, medical education, health system management, simulation, resuscitation, and research.

and encouraged. Without intellectual advances, anesthesiology is in danger of becoming a sterile technical discipline.[63] University departments of anesthesiology are increasingly experiencing pressure to emphasize clinical delivery at the expense of academic pursuits. If they succumb to these pressures, this will threaten undergraduate perioperative medicine teaching, development of critical appraisal skills among anesthesiologists, and the future of research programs that are the lifeblood of new advances that support all of health care.[64] The irony would be that by immersing themselves entirely in the clinical arena, anesthesiologists would neglect the education of medical students and trainees, thus jeopardizing the future of clinical anesthesiology practice.

While it is easy to teach others as we were taught or as we practice today, focus on the future is an essential element of education. Long-term success for the specialty will depend on our efforts in undergraduate and graduate medical education, whereas short-term success will depend on our efforts in the continuing medical education of current practitioners.[65] A different approach will be required to redefine the scope of the practice with broadened training to provide increased expertise in the evolving medical marketplace. This approach will likely include solid training in business, informatics, data management, and critical thinking on outcomes.[19,40] This paradigm shift may be

challenging and requires redirection, reallocation of assets, reeducation, and a new mindset. If successfully applied, however, it presents a means to strengthen the respected position of the specialty and to promote the medical care and practice of perioperative specialists in the rapidly changing landscape of modern medicine.[66]

VISIONS OF THE FUTURE

SCENARIO 1: TO EACH PATIENT A DEDICATED ANESTHESIOLOGIST

The scenario of a dedicated anesthesiologist for each patient is the current model of anesthesia care in much of the developed world, and many in the United States are adherents to this model. Most American residency programs are structured to train anesthesiologists to practice in this model. As discussed previously in this chapter, it is unlikely that this model of anesthesia care will be sustainable given the mismatch between surgical demand and anesthesiology personnel and the increasing pressure to reduce the cost of anesthesia. Embracing the team-based model of care delivery is required to meet current and future demands and is also consistent with trends in other health care disciplines.

SCENARIO 2: PHYSICIANS FOR THE PERIOPERATIVE PERIOD: THE PERIOPERATIVE SURGICAL HOME

Over the past 14 years, the ASA, American Board of Anesthesiology, and Accreditation Council for Graduate Medical Education have worked to develop the perioperative surgical home (PSH) model, for which the underlying principle is coordination of care throughout the entire perioperative period under the leadership of anesthesiologists.[39,67,68] The ASA Learning Collaborative on the Perioperative Surgical Home[69] is currently gathering data from numerous practices around the country that are implementing the model or parts of the model. Given that the patient-centered medical home (the basis for the PSH) has not shown consistent benefits for all patients and that some supporters of the PSH acknowledge it may not work in every population,[39] it is crucial that the model be rigorously evaluated with regard to economic considerations, its effectiveness, and its applicability to diverse practices.[70-72] Significant inertia still must be overcome for the PSH to become a reality.

SCENARIO 3: PROCESS MANAGERS AND PERIOPERATIVE CARE DIRECTORS

Although the Perioperative Surgical Home necessitates a reorganization of the practice of anesthesia, some envision a future that includes an even more drastic re-engineering of the specialty, including the way anesthesiologists are trained and how and where anesthesiologists practice.[40] In order to achieve such re-engineering, anesthesiologists will require formal training in healthcare business, process management and finance, and a broadening of their medical knowledge and experience. Perhaps most importantly, anesthesiologists would have to be trained to supervise others effectively and to work collaboratively and effectively with non-physician colleagues as care directors throughout the perioperative period. This model sometimes runs counter to the current training process, but there are already anesthesia programs that are offering novel fellowships such as operating room management. If this model is to succeed, residencies and academic programs will have to undergo major paradigm shifts.

MEETING THE CHALLENGE OF CHANGE

In an era of drastic revolution in health care, anesthesiologists can do much more "to enhance healthcare beyond prevention of intraoperative death,"[60] for certainly the specialty has much to offer beyond this. As anesthesiology looks to meet the demands of the future, it can make use of those same factors that allowed the field to make such advances in patient safety: outcomes orientation, team care, efficiency orientation, and site-of-care flexibility.[60] These factors will serve the specialty well as it adapts and responds to the transformation of modern medicine. Change will be driven by several imperatives, including shifting demographics, technological advances, patterns of surgery, and economic realities. There will be an increasing number of elderly people, high-risk obstetric patients, and children with complex medical problems requiring surgery. Thus, it is important to further increase the safety of all surgical, anesthetic, and perioperative care to minimize both short-term morbidity and long-term deterioration when vulnerable patients undergo surgery and anesthesia. Anesthesiologists must look beyond a limited view of responsibility for patient outcomes lest our contribution to medicine be trivialized.[19]

Improved monitoring, safer drugs, less-invasive surgery, and sophisticated communication networks may allow anesthesiologists and other anesthesia clinicians to extend their roles without compromising patient safety. Intensive care units may serve as a useful model, where one nurse attends to one or two critically ill patients and a small number of physicians, with one experienced intensivist, regularly assess all the patients and modify treatment plans over the course of the day. A derivative of this model could be conceptualized for future operating room anesthesia care with the inclusion of information technology advances based on telemedicine. As individual patients present with their genetic profiles, it may become possible to tailor anesthetic and analgesic therapy with increased efficacy and decreased side effects. This pharmacogenomic model would represent a major advance in patient safety.

CONCLUSION

Health care systems and processes are evolving at a rapid rate. Anesthesiology as a specialty must adapt to the changes support societal needs and to ensure that anesthesiologists remain valuable and essential leaders in the health care system of the future. Anesthesiologists must extend their physician skills in multiple areas and increasingly pursue subspecialty fellowships. Anesthesiologists have knowledge and skills that bring meaningful value in nearly all areas of medicine. Apart from traditional areas of involvement, such as operating room anesthesia, critical care, pain medicine, teaching, research, and resuscitation, there will be future opportunities for anesthesiologists in areas such as pharmacogenomics, health care system management, and new technologies.

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CHAPTER 3

Safety and Quality: The Guiding Principles of Patient-Centered Care

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KEY POINTS

1. The patient should be the focus of anesthesia care.
2. The goal of anesthesia care must be to ensure that *no* patient is harmed.
3. Preventing harm is challenging because care is complex and serious adverse events are relatively rare and often the result of many causes rather than a single one.
4. Weaknesses in "the system" are often the source of serious adverse events that are sometimes attributed to clinical incompetence.
5. Vigilance alone is not enough; a strategy of error prevention is required to prevent harm.
6. Organizations, departments, and groups must use a top-down, integrated approach and a commitment to creating a safe environment and system for safety.
7. Safety must be the first priority to create an organization that operates at the highest level of reliability.
8. Anesthesia professionals must employ a broad array of safety tactics as a foundation for their anesthesia practice.
9. Teamwork and communication among the perioperative caregivers are critical components of patient safety.
10. High-quality, safe anesthesia practice also requires a proactive, forward-looking approach that identifies successes and disseminates their characteristics widely to ensure resilience in the system.

Patients expect high quality and complete safety from their anesthesia providers. They fear the possibility of experiencing pain, awareness during surgery, and the potential for serious complications, including death.[1,2] Patients are even apprehensive about what anesthesia providers consider as routine or "minor complications," such as postoperative nausea and vomiting. Our empathy and our resolve to address these concerns are fundamental tenets for patient-centered care across the spectrum of anesthesia practice. Anesthesia providers develop a comfort with their craft, despite its inherent dangers. Over time, the administration of potentially lethal drugs, the management of apnea, and the control of altered physiologic systems become almost routine. With experience, these providers may even take for granted the inherently hazardous art and science of rendering patients insensible to pain, unconscious, and paralyzed. While meeting these patient needs demands knowledge, skills, and continuous vigilance from each individual practitioner, equally important is a system design that ensures safe practitioners; provides the appropriate drugs, technologies, policies, and procedures to foster safe practice; monitors performance of the entire process (including both outcomes and patient satisfaction); identifies safety and quality problems; and implements corrections. All of these rely on and contribute to a culture of safety and quality at all levels of the system—a culture that supports these needs not only in words but also in deeds and actions.

In 2001, an Institute of Medicine (IOM) committee identified patient safety, quality of care, and patient-centered care (ie, individualized care) as progressively increasing levels of excellence in the overall health care process.[3] This view is consistent with the tenets of other organizations that serve the public while dealing with potentially lethal outcomes (eg, the commercial aviation industry). In short, safety is the foundation on which quality (eg, the application of evidence-based approaches) and then patient-centeredness are built, but all are required to meet the goal of highest-quality care.

The demands for quality and safety start with the patient's needs and are guided by the needs of the physicians performing the procedure (medical, surgical, or diagnostic) that requires anesthesia care. Sometimes, these are competing expectations, requiring thoughtful trade-offs based on essential priorities. When balancing these trade-offs, involvement of the patient is a key to positive patient satisfaction with the overall process.

Every subsequent chapter in this text has the delivery of safe and high-quality care as its primary objectives. This chapter defines a strategy and generic principles for achieving these objectives, centering on the patient while also meeting the other demands of modern perioperative care (see **Box 3-1** for definitions of key terms). Subsequent sections in this book provide specific elements of evidence-based anesthesia care that are required to meet these strategic objectives.

BOX 3-1

The key terms commonly used to discuss quality and patient safety include the following:

- *Patient-centered care* encompasses the qualities of compassion, empathy, open and complete communication, and responsiveness to the needs and preferences of each patient.[3]
- *Quality of care* is the extent to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge.[4]
- *Patient safety* is the avoidance, prevention, and amelioration of adverse outcomes or injuries stemming from the processes of health care. These events include "errors," "deviations," and "accidents." Safety emerges from the interactions among the components of the system; it does not reside in a single person, device, or department. Improving safety depends on learning how safety emerges from the interactions of the components through analysis of "near misses" and adverse outcomes or injuries. Patient safety is a subset of health care quality.[5]
- *Quality improvement*. The US Agency for Healthcare Research and Quality defined high-quality health care as "doing the right thing, at the right time, in the right way."[6] *Quality improvement* is the process used by individuals and organizations to ensure that these goals are met through a system of constant scrutiny, measurement, review, and revision.[7]
- *Adverse event* is an injury caused by medical management that results in measurable disability.[8]
- *Accident* is an unplanned, unexpected, and undesired event, usually with an adverse consequence.[9]
- *Error* is when a planned sequence of mental or physical activities fails to achieve its intended outcome and these failures cannot be attributed to the intervention of some chance agency.[10]
- *Near miss* is an event or situation that could have resulted in an accident, injury, or illness but did not, either by chance or through timely intervention.[7] Also known as *close call* or *near hit*.
- *Human factors* refers to the scientific discipline concerned with understanding interactions between humans and other elements of a system and to the profession that applies theory, principles, data, and methods to design to optimize human well-being and overall system performance.[11]
- *Risk management* is the clinical and administrative activities undertaken to identify, evaluate, and reduce the risk of injury to patients, staff, and visitors and to identify, evaluate, and reduce the risk of loss to the organization itself.[12]
- *Resilience* allows adaptation to change during times of ambiguity or adversity. By anticipating threats and opportunities and having flexible responses to changing demands and continuous learning from both successes and failures, focus can shift toward promotion of quality and innovation.[13]

DEFINING QUALITY AND SAFETY

The concepts of quality and safety are a continuum. Some view safety as a subset of quality; most agree that quality care must be founded on safe care. One important difference is that quality is generally measured in terms of success in achieving desired outcomes, whereas safety is measured in failures, particularly catastrophic failures. Success in achieving the desired outcomes includes not only a safe experience but also one that incorporates the elements of evidence-based medicine, especially because personal provider experience is almost never adequate to evaluate either the overall positive or the overall negative consequences of a specific drug, technique, or procedure. Because anesthesia is generally not therapeutic, complete safety must be the most important goal of every anesthetic. This means a goal that *no patient is harmed from the effects of the overall anesthesia encounter.* This may seem unattainable. But, as described further in this chapter, adopting such lofty goals and committing to achieve them leads to greater safety and better care.

To the benefit of all, quality and safety have attained increasing importance in modern health care. There is a rich history of attention to the processes of improving care. Those activities can be traced to the work of Donabedian, who developed principles by which quality can be measured and improved for health care in general, but with specific applications to hospital care.[14] It was only in the late 1990s that the concept of patient safety was raised to prominence in the broad health care environment, a result of a landmark study of medical error.[14] Yet, in anesthesia, patient safety has a much richer history.[15] Indeed, the specialty of anesthesiology is often identified as the earliest adopter of patient safety principles, and it is lauded for achieving dramatic improvements in outcomes (see Anesthesia Risk and Accidents for the history of patient safety in anesthesia).[16]

The concepts of patient safety, quality improvement, and risk management are related but have important distinctions. Patient safety focuses on prevention of injury. Quality improvement generally deals with the broader spectrum of quality, including the success of treatments (see Chapter 22). Historically, risk management addressed the aftermath of adverse outcomes, especially legal issues, disclosure to patients, malpractice, and avoidance of financial loss for insurers. But now, modern risk management employs proactive patient safety goals, based on the principle that prevention of injuries via error reduction and system improvements reduces the adverse events from which malpractice awards arise. As modern health care is often plagued by a "cost conundrum" of continuing elevating costs, quality and safety choices must be weighed against the value that they provide for the patient experience and safety in relation to the cost for obtaining better outcomes.[17]

Because safety focuses on preventing rare events, it is much harder to develop an evidence base for actions that create safety. Randomized controlled trials, although possible for testing many types of quality improvement practices, are almost unheard of for trials of safety practices. Many safety initiatives arise from investigation of serious adverse events. More intuitive arguments and judgments guide the implementation of safety principles.

ANESTHESIA RISK AND ACCIDENTS

The roots of safety run deep in anesthesiology. Dating to the first survey of anesthetic deaths,[18,19] there has been a regular and continuous self-examination within the anesthesia profession to understand the causes of harm and how to prevent them. In the modern era of health care, anesthesia was the specialty that coined the term *patient safety,* which is now in the lexicon of health care and broadly applied to all medical disciplines.

HISTORY OF PATIENT SAFETY IN ANESTHESIA

The history of safety in anesthesiology may have begun with the first description and review of an anesthetic death—that of Hannah Greener, who died in 1848 during administration of chloroform for amputation of her large toe.[20] Although outcome studies were reported over the years, it was not until the landmark study of Beecher and Todd that a large population was sampled and specific causality suggested.[21] Other studies followed during the 1950s and 1960s, with a focus generally on the morbidity and mortality associated with general or regional anesthesia and the cause of death or serious injury in surgical patients.[22,23]

Safety interventions in the 1950s and 1960s focused on the development of safety features of anesthesia equipment. Features such as the fail-safe system for protecting against loss of oxygen supply pressure and pin-indexing of gas cylinders to prevent their interchange are still in use today.

The concept of "patient" safety arose in the early 1980s, in response to several factors. The first study of the contribution of human error in anesthesia was reported in 1978, followed by larger studies that focused on the sources of errors and strategies for their prevention.[24,25] In these studies, Cooper et al studied "critical incidents" to elucidate the mechanisms of what were then called anesthesia "mishaps" as multidimensional, resulting from a number of errors and other contributing factors to each event. Other reports described attributes of a specific event, such as disconnection in the breathing circuit, the relief of one anesthesia provider by another, and other generic contributors to critical events. Several studies replicated the methods and general findings in other settings and countries.[26,27]

A "crisis" of increasing costs for malpractice insurance for anesthesiologists prompted intense interest in tort reform and in reducing the number of adverse events that led to claims. The American Society of Anesthesiologists (ASA), under its then-president, Ellison C. Pierce Jr, MD, led this initiative, which resulted in the formation in 1985 of the Anesthesia Patient Safety Foundation.[28] Its activities represented the first organized efforts in health care to address patient safety as a single topic. The ASA later sponsored studies of closed malpractice claims, which led to numerous reports about causes of the most severe adverse events and their trends.[29]

Many efforts contributed to what appears to be a substantial reduction in catastrophic adverse anesthesia outcomes among relatively healthy patients.[30] Among these were improvements in educational programs; safer drugs and equipment; more intense patient monitoring (especially oxygen analyzers, pulse oximetry, and capnography); and new technologies for managing difficult airways (a specific contributor to numerous severe adverse outcomes). Standards and guidelines for anesthesia care also played a role in reducing adverse events. In 1986, the Harvard Medical School Department of Anesthesia promulgated the first standards for care[31]; these were later adopted by the ASA as national standards. It is claimed that these standards are associated with a reduction in serious outcomes among ASA physical status (ASA-PS) 1 and 2 patients in the ensuing years.[31] Many other standards and guidelines followed. **Box 3-2** summarizes key milestones in the path to safer anesthesia care.

The 1999 publication of the IOM report *To Err Is Human: Building a Safer Healthcare System* catalyzed a national movement in patient

BOX 3-2

Key Historical Influences Leading to Increasing Patient Safety in Anesthesia

Research in human error, human factors, and closed claims.

Development and routine use of pulse goniometry.

Development and routine use of capnography.

Enhanced alarms and safety features in anesthesia machines/workstations.

Development of safer anesthetic drugs.

Anesthesia Patient Safety Foundation focus on patient safety.

American Society of Anesthesiologists adoption of standards and guidelines for safe practice.

Development of new airway tools (eg, fiber-optic bronchoscopy and video laryngoscopy).

Emphasis on safety culture: cognitive science and crew resource management.

Utilization of simulation for enhanced training, identification of latent errors, and assessment.

safety.[32] It and subsequent reports recommended fundamental changes in the health care system to combat a problem with deep roots in the way patient care is organized (or disorganized), particularly the culture of health care that did not place a high priority on the overall safety of patients relative to the delivery of specific services. The IOM's report, as well as other writings, singled out anesthesiology as the one specialty that addressed patient safety early and with positive results.

CURRENT STATE OF KNOWLEDGE OF ANESTHESIA RISK AND RELATIONSHIP TO ERROR

There is a general belief that the risk of preventable death or injury from anesthesia is relatively low compared with many other medical and nonmedical risks. Yet, there are no accurate estimates of the rate of adverse outcomes in general or for an individual patient presenting with specific risk factors. One reason is that there are no standard methods for assigning causality appropriately among numerous factors, including anesthesia, surgery, the facility (and its systems), and the patient's disease. Particularly in the United States, the fear of malpractice claims hinders reporting and open, candid discussion of errors. Federal legislation, similar to that enacted in Australia in the late 1980s, now protects voluntary reporting.[33] Despite the absence of strong evidence, estimates of the risk of untoward outcome to a relatively healthy patient are believed to be on the order of 1 in 100,000 patients.[34,35] However, for patients presenting at greater risk, the risk may be on the order of 1 in 10,000, which is not different from early estimates for all patients.[34,36]

Through the recent establishment of the Anesthesia Quality Institute (AQI) in 2010 through the ASA, there is an increasingly robust mechanism for tracking and evaluating anesthesia care and opportunities for improvement. The AQI provides an infrastructure for achieving three important goals: aggregating electronic data from all anesthetics in the United States, collecting narratives about critical events, and disseminating these data for the purposes of science, education, and quality improvement. Within the auspices of the AQI, the National Anesthesia Clinical Outcomes Registry (NACOR) is the largest registry of its kind, in 2014-2015 capturing 25% of all anesthetics procedures performed in the United States, and allowing for individual practitioner metrics and local quality improvements.[37-40] Chapter 21 includes a comprehensive discussion of risk, mortality, and morbidity.

ACCIDENT MODELS

Most people, both in and out of health care, seek to assign blame to specific individuals for specific lapses in performance associated with an adverse event. Yet, the evidence demonstrates that most injurious accidents are typically complex events for which there is no single cause.[41-43] Although it would be possible to envision a scenario in which a specific act by one individual led to an accident, assigning such pinpoint causality is not a useful approach to accident prevention. Substantial research is targeted at learning how accidents occur and how humans are involved in that process. The science emerging from that research supports the concept that there are few simple solutions for prevention of accidents. However, it offers possible strategies and tactics for lowering the potential for accidents by preventing human error and its precursors (ie, the factors that promote and propagate errors) and by creating resilience in systems to respond to those errors that will inevitably occur despite the best of intentions and preventive actions.

The goal of adverse-event-free anesthesia care can be achieved only by applying a broad spectrum of prevention strategies and building resilience throughout the entire system of anesthesia care, for the overall system is no stronger than its weakest links. This section examines several models and issues at the organizational and human levels to inform our thinking about designing for failure.

THE "SYSTEM" OF ANESTHESIA CARE

Whereas anesthesia could be viewed simply as a single provider administering drugs to a single patient, that narrow perspective does not represent the intricate and multidimensional processes that characterize care delivery. Rather, the anesthesia encounter consists of several components that comprise the "system of anesthesia care." Classically, the anesthesia processes can be thought of broadly in three phases: preanesthetic planning and preparation, provision of anesthesia for the procedure, and postanesthesia care. Within each of these phases, the anesthesia provider performs a set of tasks intended to provide quality care for the patient, surgeon, or other operator and the health care organization. Achieving safety and quality requires that these anesthesia activities be synchronized with the needs of other providers, allied health professionals, technical staff, support staff, hospital or organization programs, and, especially, the patient's needs and expectations. More recently, the ASA has expanded the scope of the three phases of anesthesia care, further encompassing the perioperative period, including the preadmission to postdischarge period within the perioperative surgical home (PSH).[44] The increasingly complex interactions between all of these components comprise a "system" of care that has yet to be fully modeled for the perioperative experience. Further, this "anesthesia system" takes place within a system of systems that includes the overall course of care, and numerous elements of this larger system may interact with anesthesia care at multiple points in the delivery process. Such interactions often contribute to a less-than-optimal experience for the patient.

The Accreditation Council for Graduate Medical Education (ACGME) has established a set of eight competencies that must be met for all medical trainees.[45] One competency is to understand and know how to practice within a system of health care. That requirement arose in recognition of the interdependencies among all the members of the care team and the larger system in which they operate. In the case of anesthesia, that implies having an understanding of the requirements and needs of all other participants in the perioperative system and implementing an anesthesia plan that appropriately meets these various needs, rather than acting individually in an insular fashion.

MODELS OF ORGANIZATIONAL FAILURE

James T. Reason is perhaps the most widely cited author for conceptualizing the mechanisms of human error and system failures, although his work is founded on the basic work of Rasmussen. Their thinking derives from research in high-hazard industries, such as nuclear power, aviation, and chemical manufacture. Gaba offered insightful interpretations of this work and other research as it applies specifically to anesthesia practice.[43] The basic concepts are relatively simple: Accidents are not one dimensional; rather, they are the result of the interaction of several elements; each accident is somewhat unique in the way that elements combine to result in injury. (Note that in the context of "safety," we are addressing only those adverse outcomes that could be prevented given the application of current knowledge; death or injury that appears to be caused primarily by the patient's disease process or the unpredictable influences of drugs or operation likely cannot be altered by safety interventions.) Reason depicted the process of accident evolution in what is widely referred to as the "Swiss cheese" model (**Figure 3-1**).[10]

The Swiss cheese model illustrates that accidents are typically the result of a series of events that include precursors, which trigger or allow the chain of events that result in the final (active) adverse event. Reason termed these precursors *latent errors*. This concept is now widely accepted in understanding health care system failures. Latent factors exist regularly in any work environment. They have the potential for initiating or propagating an evolving accident. Examples are failure to maintain equipment or replace obsolete equipment, selection of low-quality supply items, poor scheduling practices that promote haste or fatigue, and case scheduling and staffing models that allow assignment of relatively inexperienced clinicians to unfamiliar cases or high-risk patients. Cultural influences are an important source of latent failures. Examples include the pressure to proceed with cases in remote locations where the resources are insufficient to meet minimal anesthesia safety requirements, pressures to move rapidly to avoid "turnover delays," pressures to assign an inexperienced provider to a case to "keep the schedule moving," a hostile atmosphere within an operating room that limits communication of concerns about quality and safety, and failure to heed a patient's warnings or concerns. Latent errors rarely lead to an immediate accident. Rather, they can be seen as a lurking enemy, or, as Reason

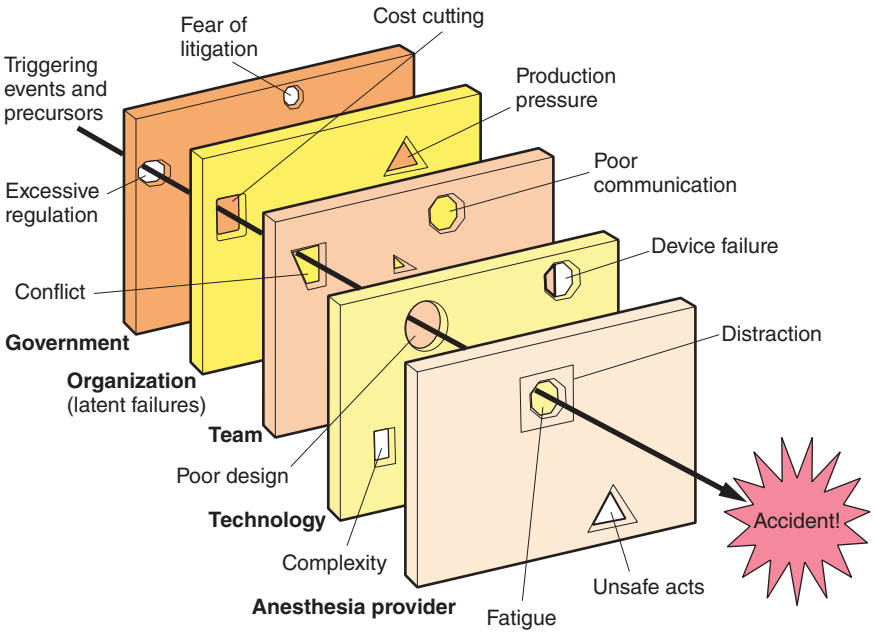

FIGURE 3-1. "Swiss cheese" model of accidents in anesthesia. [Reproduced with permission from Reason J: *Managing the Risk of Organizational Accidents*. Aldershot, Hants, UK: Ashgate Publishing; 1997.]

called them, "resident pathogens," awaiting the circumstances that will combine to produce a catastrophic outcome, often in ways that are unusual and what may be called "unpredictable." Avoiding the consequences of latent errors requires broad defenses and resilience throughout the system to mitigate evolving failure that results from alignment of the "holes in the cheese."

Reason's model highlights the need for broad and varying mechanisms to trap errors and failures during the patient's health care encounter and thus mitigate or prevent the full cascade from unfolding. His work on managing risk begins at the organizational level and offers a spectrum of strategies and tactics for accident prevention. Both the attitude and actions of the organization and each individual in the chain of care can either bolster or undermine those defense mechanisms.

There is a competing theory that postulates that prevention is not always possible or even probable. The normal accident theory (NAT), as described by Perrow,[41] characterizes some industrial systems as particularly resistant to strategies for prevention of catastrophic accidents if the systems are both complex and "tightly coupled"; that is, the connections between processes are such that one quickly affects the other in ways that can evolve into an accident that is not predictable by deterministic analysis. Fortunately, although all the patient and provider processes involved in anesthesia administration may create a "complex" system, they are not usually tightly coupled to the extent envisioned in Perrow's model, although it may occur in certain high-risk patients whose disease processes present a less-stable condition. Still, Perrow's NAT provides many lessons for anesthesia practice and for constructing resilient systems to minimize the potential for accidents.

Of special concern is that some protections and safety features can actually make systems more complex, mask impending problems, and impart a false sense of security. Further, certain prevention or mitigation strategies may affect other parts of the system in unanticipated ways and thus lead to new, unexpected risks. Anesthesia has many examples: Pulse oximetry can lead to practicing closer to the edge of acceptable levels of oxygenation or inappropriate assumptions that a functioning pulse oximeter implies adequate blood flow; automated noninvasive blood pressure monitors can fail to cycle and thus continue to present falsely high readings even in the presence of blood loss; or alarms on anesthesia monitors may be turned off to avoid "distraction" during the procedure. Moreover, the relative safety of anesthesia itself has been called an "insidious hazard," for some become complacent about anesthesia care and vigilance and assume that nothing will go wrong based on prior experience.[25]

Complacency about safety based on prior experiences has led to major disasters in a variety of organizations; a prime example is the loss of the orbiter ("shuttle") *Columbia* on February 1, 2003. The *Columbia* Accident Investigation Board identified a number of contributing latent factors that resulted in complacency within the National Aeronautics and Space Administration (NASA). A key factor was the acceptance of "normal deviation" (see the discussion of normalization of deviance in the section on the high-reliability organization model). Another was the loss of checks and balances that should have guided NASA safety efforts. Many of these latent factors resulted from the lack of serious events in the years immediately preceding the loss of *Columbia*.[46]

Reason's commentary about creating effective defenses against accidents fits well for anesthesia:

> If eternal vigilance is the price of liberty, then chronic unease is the price of safety. Studies of high-reliability organizations—systems that have fewer than their share of accidents—indicate that the people who operate and manage them tend to assume that each day will be a bad day and act accordingly. But this is not an easy state to sustain, particularly when the thing about which one is uneasy has either not happened or has happened a long time ago, and perhaps in another organization. Nor is this Cassandra-like attitude likely to be well received within certain organizational cultures.[42]

MODELS OF HUMAN ERROR/FAILURE

There has been a strong reliance on "vigilance" during anesthesia as the primary approach to error prevention, so much that the word is the motto of the ASA. Vigilance means sustaining attention.[47] It has been defined as having three components: alertness, selection of information, and conscious effort. It is a much more complex process than is immediately apparent, and vigilance is the subject of much investigation in many fields that require sustained attention to ensure safety and performance. The observant practitioner is aware of some of the many ways that vigilance can be thwarted and performance degraded. Further, vigilance is only one of a complex set of elements that comprise safe anesthesia practice.

The modern theory of accident causality and safety views the human as a component of a system. Most experts now tend to play down the operator's responsibility for accidents, perhaps because so often the attention and blame have been so heavily directed at those who are the last line of defense.[48] In fact, there is substantial evidence about human error and how humans interact with systems in diverse ways to either help or hinder the accident process. The vast majority of research has been in industry, most notably aviation and nuclear power applications, but there has been substantial investigation in anesthesia, where some of the earliest studies of human error and human factors in health care are found.

The studies of critical incidents mentioned previously identified the basic issue of human error as a component of what were termed *mishaps*.

BOX 3-3

Slips and Mistakes

Slip: The plan is adequate, but the actions fail to go as planned. These are unintended failures of execution, also referred to as lapses, trips, or fumbles. They are further divided into attentional slips of action and lapses of memory.

Mistake: The actions conform to plan, but the plan is inadequate to achieve its intended outcome. Mistakes are divided into rule based (eg, misapplication of normally good rules but not correct for this situation) and knowledge based (eg, incorrectly thinking out a solution for which there is no prepackaged solution).

Factors associated with mishaps, what would now be called *latent factors,* were identified, such as lapses in training, equipment design weaknesses, and the contribution of fatigue. In these and other areas, the science of human performance and human factors has revealed much more about the weaknesses of humans and the many ways in which we can fail, including how system design and other factors can influence our performance and conspire to weaken even the most expert clinician.

Human error is the subject of intense investigation in the fields of human factors, ergonomics, and industrial psychology. Again, James Reason provided an overview of the subject.[10] Performance is defined at three levels: skill based, rule based, and knowledge based. Error is defined as the failure of planned actions to achieve their desired ends without the intervention of some unforeseeable event. Errors are divided into two main types: slips and mistakes (**Box 3-3**). The thoughtful practitioner will consider that his or her slips and mistakes vary in type and cause, most of all recognizing that all forms of error require efforts toward prevention, or mitigation of their consequences because errors occur despite the best of efforts.

Many factors influence vigilance and performance (performance-shaping factors), including fatigue and sleep deprivation, environmental influences, production pressures, human-interface design, and teamwork. Other factors associated with adverse events in anesthesia that either may promote errors or may foster their propagation have been identified.[24,25] We consider some as examples of the issues that anesthesia providers must address to maintain accident-free performance throughout a professional career. Measures to prevent performance decrement or to help maintain optimal performance are described in the section Creating Safety at the Organizational and Departmental Levels.

Fatigue and Sleep Deprivation There is evidence (in trainees) that shows an association between sleep deprivation and human errors, including lack of attention to task, serious auto accidents, and medical errors involving both diagnosis and treatment.[47,49,50] There are many examples of large-scale industrial accidents for which sleep deprivation or fatigue was identified as a major contributing factor.

Howard et al reviewed the literature on sleep and fatigue with particular reference to anesthesia.[51] Among the key findings were the following: (1) Inadequate sleep degrades performance; (2) individuals require different amounts of sleep to feel awake and alert; (3) the failure to obtain adequate sleep results in a sleep "debt" that is cumulative and can only be reduced by sleep to pay back the debt; (4) circadian rhythms have an important influence on both the tendency to sleep and the ability to sleep, with the circadian lull associated with degraded performance between 2 and 6 AM and 2 and 6 PM; and (5) stimulants such as caffeine can aid in maintaining alertness and wakefulness, but side effects must be understood to use these effectively.[52]

In response to sleep deprivation data and the highly publicized and tragic death of Libby Zion at a New York Hospital, the ACGME instituted a policy in 2003 for a reduction in resident duty hours with a subsequent revision to intern duty hours in 2011. The impact of reduced duty hours has been variable. Studies showed reduced attentional failures among interns working in the intensive care unit[50] and decreased short-term mortality in high-risk medical patients[53] but did not show clear mortality reductions in surgical patients.[53] A meta-analysis by Jamal and colleagues revealed no overall significant improvement with decreased duty hours, thus suggesting that individual practitioner performance is only one element contributing to safer care in surgery.[54]

Transitions Among Care Providers ("Handoffs" or "Handovers") There are conflicting findings about the impact of handoffs or handovers among anesthesia providers to mitigate the effects of fatigue, boredom, hunger, and so forth. Cooper et al examined critical incidents associated with relief of one anesthesia provider by another.[55] They concluded that, overall, relief provided more benefit from detecting undiscovered problems than harm from transferring responsibility to a provider with less serial knowledge of the specific patient and procedure. These conclusions were verified by interpretation of data from a similar study by Short et al.[56] More recently, Arbous et al found that a change of anesthesiologists was associated with greater incidence of severe morbidity and mortality.[57] Yet, routine breaks are generally found to be useful and necessary in anesthesia and in high-hazard industries. Provisions for adequate transfer of critical information and situational awareness are required.

Cooper suggested a specific set of guidelines for conduct of handoffs, which was recently updated.[58,59] The hazards of transitions in care are now more widely recognized in health care and receiving increasing attention for remediation.[60,61] More handoffs now occur among trainees as a result of ACGME work-limitation requirements that are intended to mitigate the consequences of sleep deprivation and fatigue. Lane-Fall et al reviewed recommendations for content and resident training curricula for anesthesia handoffs, with particular attention to the I-PASS* handoff protocol, which was originally designed for pediatric settings but is also applicable to perioperative transitions.[62,63] They advocated linking handoffs to improved clinical and patient-centered outcomes and identifying best practices for anesthesia handoffs in different clinical settings.

Environmental Factors Many environmental factors can affect the performance of the anesthesia provider. Among these are noise, extremes of temperature and humidity, lighting, and toxic vapors.[64] Listening to music or reading during anesthesia administration are controversial issues with conflicting trade-offs.[65,66] There are no robust studies in health care or simple extrapolations from studies in other fields to guide the development of evidence-based standards. Rather, good judgment appears to be the best guideline. Background music can alleviate stress and boredom, but different musical tastes may lead to varying effects among the operating team. Loud music or other noises can obscure verbal communications and be especially disruptive during periods of high workload or management of critical events. Access to electronic resources in the operating room from computers, smartphones, and tablets offers practitioners practical tools to instantly look up information for a case, manage perioperative issues, and alleviate boredom during uneventful intervals. However, it also opens avenues of distraction that can denigrate vigilance and patient safety. Although not yet specifically reported in the anesthesia literature, there is concern from both the public and practitioners regarding "distracted doctoring."[67] Electronic distractions are intuitively problematic and would be difficult to justify in an accident investigation involving pilots, air traffic controllers, train operators, or anesthesia providers, among others.

Human Factors and Human Interface Design Human factors engineering (HFE) is a broad field that encompasses all of the different aspects in which humans interact with systems.[68] The importance of human factors, especially the design of the human-machine interface, is well known in other fields but greatly underappreciated in health care.[11] The goal of HFE is to "design tools, machines, and systems that take into account human capabilities, limitations, and characteristics."[69] Given that anesthesia is technology intensive, human factors play an important role in prevention of errors and adverse outcomes.

Several studies examined how the design of displays and of anesthesia alarms have an impact on equipment use and errors.[64,70,71] The results indicated that technology is not generally well designed to accommodate the ways people use it. There are numerous examples of how the design of a device interface can be especially dangerous.[72-74] The design of anesthesia monitors is particularly problematic. Anesthesia providers work in facilities that have various models or different suppliers of devices.

*I-PASS: I = illness severity, P = patient summary, A = action list, S = situational awareness and contingency plans, S = synthesis by receiver.

For example, differences in software design or data displays can cause confusion and distract the provider from other important tasks that should have higher priority. A new standard requiring attention to human factors in the design of medical devices is intended to address these issues, but it will be years until the effects can be felt.[75]

Production Pressure Production pressure refers to "overt or covert pressures and incentives on personnel to place production, not safety, as their primary priority."[76] Based on a survey of anesthesiologists in California, Gaba et al reported that nearly half of the respondents had witnessed instances of what they believed to be unsafe actions by an anesthesiologist because of production pressure.[76] These included internal pressures (eg, to foster good relations with a surgeon, accrue personal income) and external pressures (eg, proceed rather than cancel a case to appease patient or family, accept an unfamiliar patient or procedure to foster facility throughput).

Teamwork The importance of good teamwork and communication is now more widely recognized in health care, especially for surgical teams. A substantial body of literature from high-hazard domains, especially aviation, and in health care demonstrates the value of teamwork for successfully preventing and managing critical situations.[77-79] Gaba et al were the first to develop teamwork and crisis management training techniques for health care, adapting crew resource management (CRM) techniques from aviation for applications in anesthesia.[80] These approaches have since been extended to nearly all health care settings but are particularly applicable to those where rapid action is required to successfully treat acute complex events, such as dire surgical emergencies.[81]

Box 3-4 lists some characteristics of effective teams.[77,82,83] These definitions and characteristics, derived from other industries, generally apply to health care and to anesthesia practice. Good teamwork can prevent errors or mitigate their impact. Teamwork is vital to the successful management of critical events. The team within which anesthesia providers work varies depending on the setting, but it typically includes at least a surgeon, a circulating nurse, a surgical technician, and other support personnel, including environmental workers; technicians (eg, blood bank, laboratory, or radiology); and clerical personnel. Within the broad system of care, the team can include those who provide care pre- and postoperatively and specialists, such as radiologists, pathologists, and intensivists. The immediate operative team has been given the most attention for training and research.

Surgical teams have several distinguishing features that create obstacles to effective performance. The hierarchy in surgical care places physicians above other workers. It is common for surgeons to be accorded higher status and to assume a self-designated role of "captain of the ship." Whereas leadership is a key feature for team success, the person in that role should vary depending on the situation. Similarly, some anesthesia providers may treat other team members as subordinates rather than colleagues. High-reliability organization (HRO) theory (see The Elements of Safe, High-Quality Anesthesia Care and the discussion of the HRO model in that section), which is based on characteristics of organizations that function at high levels of safety, calls for a nonhierarchal culture in which the leader is the one with the most expertise, not the highest status. Conflict among these roles can complicate the management of acute operative events, especially when the care team does not work together regularly (eg, during nights and weekends when the care team consists of "night call" personnel from various work rosters).

BOX 3-4

Some Effective Practices of High-Performance Teams

Introduce all members of the team to each other at the start of each procedure.

Regularly conduct *preoperative briefings* with the entire operative team, which can be done via a specific checklist as described by Lingard et al.[82]

Use specific *communication protocols* within the team (SBAR is gaining increasing acceptance. It calls for a specific sequence for describing the patient's status: the situation, the background, assessment, and recommendations).[79]

Establish communication standards such as "read back" of all verbal orders (eg, medications).

Conduct *debriefings* with the team following unusual occurrences, near misses, or critical events.

Establish an environment that encourages cross-monitoring and backup behaviors across the entire team.

Create a language that signifies recognition of potential hazards.

Practice for emergency situations.

SOME SPECIFIC HAZARDS ASSOCIATED WITH ANESTHESIA

There are a seemingly infinite number of case reports of specific hazards and complications of anesthesia that were largely preventable, although a litany of isolated cases is perhaps less helpful than a series of organized observations. Studies of closed malpractice claims, funded by the ASA, have examined many of these events in a more systematic manner, one that assists in developing action plans for reducing risks. These closed claims studies have explored several categories of adverse outcomes, the most notable addressing errors related to airway management, monitoring, sudden cardiac arrest during spinal anesthesia, equipment failures, and nerve injuries.[29,84,85]

ADVERSE RESPIRATORY EVENTS

Events associated with management of respiration are the most serious remaining hazards in anesthesia, as evidenced by data from the ASA closed-claims analyses.[84] The three most common causes of death and brain damage are inadequate ventilation, esophageal intubation, and difficult tracheal intubation. The large majority of cases in the first two groups were judged to have been preventable if "better monitoring" had been used. For management of the difficult airway, prevention is more challenging. Peterson et al reported that "persistent failed attempts at intubation were associated with an outcome of death or brain damage in claims in which a 'cannot ventilate and cannot intubate' emergency situation developed prior to surgical incision."[86] They concluded that this was supporting evidence for limiting conventional ventilation efforts to three attempts before using other strategies.

Despite substantial advances in technologies that aid endotracheal intubation and some helpful, although far from foolproof, methods of airway assessment, there remain many opportunities for unanticipated difficulties with airway management, tracheal intubation, and effective ventilation (see Chapter 32). Each is an opportunity for a serious adverse outcome. Although airway management skills are greatly emphasized during training, there is great variance in experience and abilities among anesthesia providers, as are the opportunities to practice emergency skills. Thus, periodic retraining and practice in the application of difficult airway management protocols is prudent. (This is an example of the value of simulation as a tool for learning and maintaining skills that may be needed infrequently but are essential for patient safety.)

MONITORING AND ALARMS

Failure to monitor the patient adequately is an important contributor to anesthesia-adverse events. Aside from failures of vigilance, which are often related to performance-shaping factors, monitoring technology design and lack of experience with technology can contribute to adverse outcomes. There are numerous ways in which pulse oximetry, capnography, and automated noninvasive blood pressure monitors can give false information, leading to missed or incorrect diagnoses. The failure to use alarms has led to a requirement in the relevant standard that when a pulse oximeter is used, the variable pulse pitch tone and low-threshold alarm of the oximeter must always be audible.[87] Similarly, when capnography is used, the end-tidal carbon dioxide alarm must be audible.

MEDICATION ERRORS

Medication errors are among the most frequent errors in anesthesia and in health care practice in general.[25] Similarity of drug names, containers,

and label colors contributes to the ease by which such errors can be made, especially during periods of high stress. Dosing errors are also common and related to the frequent need for individual numerical calculations when drawing and mixing drugs for bolus administration or intravenous infusion. Choosing the wrong form of drug (eg, among various insulin formulations), flushing a catheter with a solution containing another potent drug, and confusion in the programming of infusion pumps are other examples of ways in which patients can be injured.

An obvious recommendation for prevention of some medication errors is to admonish the provider to read the label carefully.[88] Another tactic is to read each label three times. Yet, human factors issues are widely recognized as contributing greatly to medication errors, especially because of similarity of drug names, the small or obscure print on vials or ampoules, and the failure to organize medication carts optimally to avoid errors. Distractions and production pressure also are likely contributors to medication errors. No universal remedy for prevention has been identified. There is a standard for label colors and grouping by drug type, but some argue that it is unlikely to be effective, and, if anything, all drug labels should be in black and white to force careful reading of the drug identity and concentration.[89] Numerous health care organizations may implement bar-code technology to address this hazard in other clinical environments, but this practice is not widespread.

COGNITIVE ERRORS

While cognitive errors have been studied extensively in the field of cognitive psychology, their contribution to errors in medical and anesthesiology-related decision-making have only been appreciated since the turn of the millennium. Gaba has described three forms of fixation errors, including "this and only this" (fixating on a single diagnostic possibility to the exclusion of others—a form of "tunnel vision"), "everything but this" (searching among many possibilities but not including the real explanation), and "everything is OK" (persistent belief that there is no problem in spite of substantive signs there is a problem).[80] More recently, Stiegler and colleagues have catalogued cognitive errors specific to anesthesiologists based on previous cognitive psychology work (see **Box 3-5**).[90-94] Based on an anesthesiology faculty survey, the most prevalent cognitive errors in anesthesiology were anchoring, availability bias, and premature closure.[92] Stiegler and colleagues studied cognitive processes for decision-making, rationalization, and diagnosis among anesthesiologists[90,91] and determined that anesthesia care, which requires rapid and complex decision-making, is particularly prone and susceptible to cognitive and decision-making errors. As practitioners, anesthesiologists should be aware of the cognitive difficulties that can lead to decision and diagnostic errors, embrace the possibility that decision and diagnostic errors will occur, and employ preventive tactics to avoid error, discussed further in this chapter.

EQUIPMENT ERRORS AND FAILURES

Current anesthesia machines and associated technology incorporate substantial safety features (see Chapter 35), which have been developed over decades in response to specific series of patient injuries associated with failure or misuse of equipment. Equipment failure is frequent and can occur in many ways, but it rarely causes injury directly.[24,87,88] When there is an equipment-associated injury, it is more likely to be from misuse than from overt failure of a device. Whereas the end user may

BOX 3-5

Cognitive Error Catalogue

Cognitive Error	Definition	Illustration
Anchoring	Focusing on one issue at the expense of understanding the whole situation	While troubleshooting an alarm on an infusion pump, you are unaware of sudden surgical bleeding and hypotension
Availability bias	Choosing a diagnosis because it is in the forefront of your mind due to an emotionally charged memory of a bad experience	Diagnosing simple bronchospasm as anaphylaxis because you once had a case of anaphylaxis that had a very poor outcome
Premature closure	Accepting a diagnosis prematurely, failure to consider reasonable differential of possibilities	Assuming that hypotension in a trauma patient is due to bleeding and missing the pneumothorax
Feedback bias	Misinterpretation of no feedback as "positive" feedback	Belief that you have never had a case of unintentional awareness because you have never received a complaint about it
Confirmation bias	Seeking or acknowledging only information that confirms the desired or suspected diagnosis	Repeatedly cycling an arterial pressure cuff, changing cuff sizes, and changing locations, because you "do not believe" the low reading
Framing effect	Subsequent thinking is swayed by leading aspects of initial presentation	After being told by a colleague, "this patient was extremely anxious preoperatively," you attribute postoperative agitation to her personality rather than low blood sugar
Commission bias	Tendency toward action rather than inaction; performing unindicated maneuvers, deviating from protocol; may be due to overconfidence, desperation, or pressure from others	"Better safe than sorry" insertion of additional unnecessary invasive monitors or access, potentially resulting in a complication
Overconfidence bias	Inappropriate boldness, not recognizing the need for help, tendency to believe we are infallible	Delay in calling for help when you have trouble intubating because you are sure you will eventually succeed
Omission bias	Hesitation to start emergency maneuvers for fear of being wrong or causing harm; tendency toward inaction	Delay in calling for chest tube placements when you suspect a pneumothorax because you may be wrong and you will be responsible for that procedure
Sunk costs	Unwillingness to let go of a failing diagnosis or decision, especially if much time/resources have already been allocated; ego may play a role	Having decided that a patient needs an awake fiber-optic intubation, refusing to consider alternative plans despite multiple unsuccessful attempts
Visceral bias	Countertransference; our negative or positive feelings about a patient influencing our decisions	Not troubleshooting an epidural for a laboring patient because she is "high maintenance" or a "complainer"
Zebra retreat	Rare diagnosis figures prominently among possibilities, but physician is hesitant to pursue it	Try to "explain away" hypercarbia when malignant hyperthermia (MH) should be considered
Unpacking principle	Failure to elicit all relevant information, especially during transfer of care	Omission of key test results, medical history, or surgical event
Psych-out error	Medical causes for behavioral problems are missed in favor of psychological diagnosis	Elderly patient in postanesthesia care unit is combative—prescribing restraints instead of considering hypoxia

Reproduced with permission from Stiegler MP, Neelankavil JP, Canales C, et al: Cognitive errors detected in anaesthesiology: a literature review and pilot study, *Br J Anaesth*. 2012 Feb;108(2):229-235.

be at fault, human factors research dictates that causes related to the design of technology and the lack of training and practice are equally, if not more, responsible. Among the legendary failures associated with poor human factors are the failure to turn on a ventilator that was briefly suspended during measurement of cardiac output or performance of radiologic studies or the accidental, unnoticed disconnection of an intravenous or arterial pressure cannula, leading to blood loss or failure of fluid or drug administration. Users can reduce hazards by ensuring they obtain adequate training before using a new device, conducting a systematic preuse inspection of devices, and using backup monitoring devices as aids to vigilance. Never turning off an alarm is an essential precept to safe care.

ERRORS ASSOCIATED WITH A LACK OF STANDARD PRACTICE AND UNUSUAL SITUATIONS

Due to the constantly evolving complexities of anesthesia, every avenue for a potential adverse event cannot be predicted, and system safety protocols cannot prevent every possible medical error. In fact, adverse events can emerge, without anticipation, from usual circumstances, unfamiliarity with new equipment or new environments, and even pitfalls into which we would not fall in the absence of acute stress. A few examples include leaving a Passy-Muir valve on a tracheostomy and therefore causing lung barotrauma or administering undiluted phenytoin, thus causing refractory hypotension and fatal arrhythmias. Goldhaber-Fiebert and Cooper offered many such examples based on a convenient sample of clinician experiences.[59]

As a result, anesthesia provider organizations must be prepared to react to the unexpected with an environment that supports the individual practitioner during the acute situation and provides mechanisms for the organization to learn from an usual event. The remainder of this chapter provides both theory and practical strategies to develop an organization that learns from the unexpected. However, this type of culture change starts from the individual provider who embraces the fact that unexpected events will occur, who reports unexpected events for further review, and who participates in the channels to improve the ultimate safety of the entire organization. This type of culture change ultimately augments the resilience of an organization to adverse events and helps an organization manage events that support both the practitioner and ultimately the next patient undergoing anesthesia.

THE DIMENSIONS OF QUALITY

Numerous definitions of quality exist, but a widely accepted definition is that of the IOM, noted previously: Quality is the "extent to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge."[4] Thus, quality represents not a distinct entity or end point but a continuum in the process of meeting the rational expectations of others who interact with the providers of health care services. High-quality anesthesia care implies satisfaction in several domains, including patient-centeredness, efficiency, cost-effectiveness, communication, collaboration and responsiveness to other members of the surgical or procedural team, and a proactive view toward performance improvement. Two major concepts are inherent in the IOM definition of quality: measurement (ie, "outcomes") and evidence-based care (ie, "current professional knowledge"). Inherent in the definition of quality is the view that safety is the essential foundation for quality and that high-quality practice cannot be achieved in the absence of safe practice. Another definition is that of the Agency for Health Care Research, also noted previously: Quality is "doing the right thing, at the right time, in the right way, for the right person—and having the best possible results."[6]

Donabedian, a pioneer in the genesis of the quality movement, proposed that quality could be evaluated by examining its major components: structure, process, and outcomes.[14] Structure involves the facilities and environment in which care is delivered (eg, governance, policies and procedures, and specific details, such as cleanliness, attractiveness, ease of access, noise levels, privacy); process involves how care is actually delivered, including the interactions between clinicians and patients (eg, the elements of communication, including listening, sensitivity, compassion, the development of trust); outcomes involve measures of results of the care provided (eg, mortality, morbidity, speed of recovery). Inherent in these evaluations of quality are the patients' perspectives on each of these areas; thus, the role of the consumer (especially the patient) in the evaluation of health care quality has increased considerably in recent years.

The IOM went further in defining quality, by identifying six desired characteristics of health care. Thus, high-quality care should be safe, timely, effective, efficient, equitable, and patient centered (often abbreviated as STEEEP, for ease of recall). Here, also, the concepts of measurement and current knowledge are apparent throughout.

The relationships among providers are key elements in the care process, especially in an era when complex care management is provided by specialists and subspecialists who focus on specific aspects of care. That complexity often leads to communication lapses and fragmentation without subsequent integration into a coordinated system of care that focuses on the patient's needs for understanding, planning, and decision-making. Thus, patients often rate communication as one of the most important components in the evaluation of quality health care, whereas physicians often rate technical abilities as considerably more important than communication.[95]

Eliminating these lapses in communication is essential for both patient compliance and patient satisfaction; eliminating the lapses benefits both process and outcome in the delivery of care. Further, it minimizes the frustrations that patients and families experience as a result of conflicting or inadequate communications among professionals, leading to mistrust of the provider by the consumer. Finally, the development of relationship-centered care teams, in which all parties have developed a pattern of open communication and mutual respect and trust, increases both safety and quality in multiple industries, including health care.[96]

A holistic approach to quality and safety should include analysis of successes as well as failures. Our work occurs within a complex system, and promoting adaptability and resilience among practitioners and organizations will mitigate harm even during times of stress and uncertainty. Shifting focus from a preoccupation about failures to an appreciation of opportunities depends on and contributes to an authentic safety culture.[13]

These concepts apply as much to the discipline of anesthesiology as to other disciplines in health care. Anesthesia providers, as individuals and departments, must institute these principles, including practical measurement of outcomes and the development of relationship-centered clinical teams, if they expect to practice at the higher levels of the quality spectrum (ie, beyond the fundamental level of safe practice).

THE ELEMENTS OF SAFE, HIGH-QUALITY ANESTHESIA CARE

Creating a safe, high-quality practice of anesthesia depends on a combination of broad strategies and effective tactics for day-to-day work. Many models for establishing safe environments and practices and for ensuring quality have been described, but there is no empirical evidence from controlled studies to demonstrate that a specific model is superior to others. Still, there is face validity from qualitative studies in specific industries and organizations to suggest that having an overall systematic approach leads to both safer and higher-quality care. Indeed, a combined report from the National Academy of Engineering and the IOM emphasized that systems approaches to health care delivery were most likely to transform health care to deliver the goals of safe, timely, effective, efficient patient-centered care in the future.[97]

THE HIGH-RELIABILITY ORGANIZATION MODEL

Although experts promulgated several models for managing quality (see Chapter 22), there are fewer directed primarily at safety. For the latter, expert consensus formulated the concept of the HRO from observations in highly hazardous industries that, despite operating under conditions of high risk, have many fewer serious accidents than expected.[98,99] Such industries included naval aviation and nuclear power. Weick and Sutcliffe

further described how organizations can be successful if they appropriately "manage uncertainty."[100] Gaba applied these concepts to health care.[43]

Weick and Sutcliffe[100] listed the five key elements that characterize a typical HRO: *preoccupation with failure, reluctance to simplify interpretations, sensitivity to operations, commitment to resilience, and deference to expertise*. Simply stated, an organization that is truly committed to prevention of failure and harm puts safety as its number one priority. In a true HRO, the interests of production and speed do not supersede the need to ensure safety.[43]

An HRO is never complacent about the potential for failure, always considering what may go wrong with current or new systems. It worries about the small details of how people actually do their work, not how management imagines how it is supposed to be done. It recognizes that no matter how much prevention is done, errors and unpredictable failures will still occur; thus, it prepares for failure and practices regularly for both failure prevention and recovery. And, in solving problems or managing a crisis, it defers to those who have the most expertise rather than adhering to seniority or rank.

Practically speaking, HROs are also noted for organizational learning, certainly not only from accidents and near misses but also from successes. Health care now embraces the process of root cause analysis (RCA).[12] An RCA is applied to analysis of potentially harmful events in an effort to understand the many elements that contribute to an event. It is not enough to analyze; practitioners must put the findings to use to design and implement corrective intervention. Failure mode and effect analysis (FMEA) is one of several industry techniques to study new processes proactively before an adverse event occurs.[101] Safety analysts use FMEA to identify potential failure modes and key points where barriers are needed to minimize the potential for failure (see Chapter 22 for a more detailed discussion of RCA and FMEA as risk-reduction strategies). However, a unilateral focus on errors (ie, failures) misses the opportunities to identify behaviors and practices that are highly successful. These also should not be ignored, for dissemination and widespread implementation of these characteristics are essential features of resilient systems and HROs that avoid future failures. Techniques such as "prospective hindsight," wherein an operational team (manufacturers, oil and gas prospectors, etc) envision a future failure or disaster and then investigate in detail the factors that contributed to that simulated failure, are viewed as effective tools for ensuring future success. Too often, success is taken for granted in health care and not studied or disseminated widely due to complacency.

Vaughan described the concept of "normalization of deviance" that arises when an otherwise safe organization drifts into unsafe conditions.[102] In analyzing the sociological features of the disintegration of the *Challenger* orbiter ("shuttle") in 1986, Vaughan identified how NASA, under intense financial and political pressures, evolved from an organization that had once highly valued safety to one that gave production a higher priority. In anesthesia practice, production and other pressures can also result in the normalization of unsafe practices. Philipp and colleagues have advocated that many such shortcuts should not be normalized. Examples include failure to examine laboratory values prior to an operation, failure to place standard monitors prior to performing a peripheral nerve block for regional anesthesia, failure to properly monitor effects of neuromuscular blocking agents in every patient, and removing monitors at the end of general anesthesia before the patient is fully awake and stable.[103]

This critical shift in emphasis has direct applications to anesthesia and surgery. To ensure safety and quality, strategies and tactics must be implemented at all levels throughout an organization, from senior management to bedside provider. That process has two major elements of responsibility: the organization and the individual.

CREATING SAFETY AT THE ORGANIZATIONAL AND DEPARTMENTAL LEVELS

The organization is responsible for creating a safe culture throughout its various levels (Chapter 22 focuses on quality improvement at the departmental and system levels). Culture is the "shared values and beliefs that interact with an organization's structures and control systems to produce behavioral norms."[42] More simply stated, it is "the way we do things around here." Cultural characteristics are usually deeply ingrained, not immediately visible, and often difficult to modify. Yet, it is the culture that defines the overall commitment of an organization to safety. Although highest reliability can likely only be achieved within a consistent culture of safety across an organization, the perioperative subcultures and anesthesia practices and departments can establish strong safety cultures within their sphere of influence. Mohr et al referred to these smaller elements as "microsystem environments" and emphasized that safety and quality must be applied at these levels, as well as in the more global "macrosystems environments" (ie, it must be brought from the corporate or departmental office to the bedside to be effective).[104] In contrast, the individual practitioner working in various environments (eg, locum tenens practice) may find it difficult to achieve an overall high-quality safe practice in an organization that gives only lip service to safety.

There is a growing literature about *safety culture* (also referred to as *climate*; the terms are similar but not synonymous) in health care.[105,106] One technique to assess the organizational culture is to conduct periodic surveys. Helmreich and Merritt reported on use of one survey instrument, the Operating Room Management Questionnaire, and compared attitudes of surgeons to pilots, whose safety culture is generally believed to be superior to that found in many industries as a result of long-standing attention to safety training and interventions.[107] Although there are many similarities with pilots, surgeons often expressed attitudes that interruptions in the continuity of care was a greater risk than fatigue, a view that is not aligned with the principles of safety science. These views have been tempered by more current evidence and by the regulations on work hours imposed by ACGME and others. Flin et al reported on results of a survey from anesthesia departments in the United Kingdom with a similar finding about the effects of stress and fatigue.[108] Although perceptions of teamwork were generally positive, only 65% of respondents perceived that operating room personnel worked well together as a team. Respondents also reported variable compliance with procedures and policies. Similar findings have been replicated for operating room teams.[108] Notably, physicians and nurses have different perceptions of the quality of teamwork by their colleagues—physicians generally rate themselves as much better team players than do their nursing colleagues.

Extrapolating from the previous descriptors of an HRO, we can imagine that a safe perioperative culture demonstrably places safety as its priority with regular meetings of the group and teams; provides organizational learning via reporting systems that are open, fair, and not punitive; has a formal and active quality improvement process; implements corrective actions on learning of unsafe practices; has policies and procedures that define standard operations; has regular training for common emergencies; is nonhierarchical during emergencies; rewards those who raise safety concerns and has open discussions about those concerns; has processes for briefing and debriefing about near misses and adverse events; has standard processes for communication among providers, especially for transitions in care; and uses other similar processes and attributes. Relatively few organizations have these attributes, especially those related to multispecialty analyses of the causes of errors and adverse events; too often, these analyses take place in parallel processes that result in the allocation of blame rather than resolution of the root causes that are embedded in the larger system or the interfaces between services or providers

There has been much more attention given in recent years to improving safety culture in the operating room. Sacks et al reviewed the literature on interventions aimed at improving teamwork, communication, and safety climate.[109] They concluded that there are "promising interventions" for improving safety culture and that "culture improvement appears to be associated with other positive effects, including better patient outcomes and enhanced healthcare efficiency (p. 465)" (such as reduced postoperative complications and mortality and fewer operating room delays, respectively). Weller et al presented a framework for overcoming barriers to a positive safety culture and suggested a "seven-step plan to overcome the barriers to effective team communication that incorporates education, psychological and organizational strategies."[110] At the heart of that plan is improving information sharing throughout the patient care process (**Box 3-6**).

More recently, the medical industry is drawing from business and organizational-behavior literature regarding team training and "psychological

BOX 3-6

Seven Actions to Overcome Barriers to Team Communication in Health Care

Action	Description
Teach effective communication strategies	Teaching structured methods of communication, such as "SBAR" handovers, can improve patient outcomes.
Train teams together	Teams that work together should train together. Training that includes all members of the team improves outcomes.
Train teams using simulation	Using simulation is a safe way to practice new communication techniques, and it increases interdisciplinary understanding.
Define inclusive teams	Redefine the team of health care professionals from a collection of disciplines to a cohesive whole with common goals.
Create democratic teams	Each member of the team should feel valued; creating flat hierarchies encourages open team communication.
Support teamwork with protocols	Use procedures that encourage information and procedure sharing among the whole team, such as checklists, briefings, and information technology (IT) solutions.
Develop an organizational culture	Senior champions and department heads supporting health care teams must recognize the imperative of interprofessional collaboration for safety.

Reproduced with permission from Weller J, Boyd M, Cumin D: Teams, tribes and patient safety: overcoming barriers to effective teamwork in healthcare. *Postgrad Med J*. 2014 Mar;90(1061):149-154.

safety" and how it influences organizational learning, quality, and safety. Edmondson highlighted the importance of organizational culture to promote strong positive team environments to create "learning organizations" that, ultimately, add value and produce better performance within product or service industries. Her work endorses several facets of organizations that promote a learning culture and foster innovation and resilience: creating safe environments for individuals to speak up and report problems that they recognize, as well as creating an environment that invites collaboration, experimentation, and reflection.[111] She advocates for a "task interdependence" approach, one in which connectedness and cross-monitoring allow for team success even during times of uncertainty and challenge. As anesthesiologists represent medical leaders in the operative and perioperative environments, it is imperative for anesthesia practitioners to employ leadership strategies that promote teamwork and safety culture within their medical organization.

When there is an adverse event, in addition to the impact on the patient, there is almost always a negative impact on the provider who was involved. Anesthesiologists may be at higher risk for stress-related disorders,[112,113] as suggested by higher drug abuse and suicide rates.[114] From survey responses of 659 anesthesiologists, Gazoni et al reported that 84% had been involved in at least one unanticipated death or serious injury. The most common emotional consequences included repetitive reliving of the event, anxiety, guilt, fear of litigation, depression, sleeplessness, fear of judgment by colleagues, anger, professional self-doubt, and defensiveness. Sixty-seven percent of those involved with a catastrophic event felt that their ability to provide patient care was compromised in the first 4 hours after the event. But, only 7% were given time off. It is not yet known the extent of more long-term impact, and some respondents reported they felt like they never made a complete recovery.[115] Some guidance for providing support for the provider, which may also be protective for care to subsequent patients, is beginning to be suggested, but research is in its early stages.[116]

PRACTICAL ELEMENTS FOR THE PRACTITIONER FOR PRODUCING SAFE, HIGH-QUALITY PATIENT CARE

Importance of Instilling Values of Patient Safety, Quality, and Patient-Centeredness Safety demands that each individual, as well as the organization, make preventing any injury or harm to the patient the highest priority. For the individual clinician, a continual commitment to safe practice includes avoidance of unnecessary risk-taking and avoidance of corner cutting, an almost-unending anticipation of what might go wrong, projection of actions in anticipation of failure, and, above all, mindfulness. Weick and Sutcliffe described mindfulness for HROs as organizing in such a way that they "better notice the unexpected in the making and halt its development."[100] The concept applies equally to the individual practitioners and members of the perioperative care team.

Clinicians have a good reason aside from patient safety to be eternally mindful: Those who lead, design, and manage local care systems may have an equal or greater responsibility for an adverse event. But, when systems fail, blame is usually assigned, fairly or not, to the clinician closest to the last action in the chain. Protecting oneself from the impact of system failures is, if nothing else, an act of self-preservation.

Just Culture James Reason introduced the concept of "just culture" to reconcile the tension between "no blame" of individual practitioners and accountability about what is acceptable or unacceptable behavior.[42] In the past decade, David Marx further developed this concept and differentiated between "human error," "at-risk behavior," and "reckless behavior." As shown in **Box 3-7**, these breaches in duty to the patient should elicit system and institutional responses of consoling the provider, coaching the provider, or disciplining the provider, respectively.[117] Leonard and Frankel developed a corresponding algorithm to assess if caregivers' actions were the result of impaired judgment, malicious action, reckless action, risky action, or unintentional error and linked this assessment with recommended responses.[118] Ultimately, balancing a "no-blame" culture (one that seeks to bolster systems-based solutions to head off inevitable human errors) with consistent and clear standards for individual professional accountability allows us to ensure high-quality patient care.

Maintaining Vigilance and Mitigating Performance Decrement Although anesthesia practitioners cannot solely rely on vigilance to protect the patient from harm, it remains the strongest underpinning of safety in anesthesia. This requires that the anesthesia provider must maintain alertness and be aware of, compensate for, and counteract the forces working against vigilance. This also requires mindfulness about the state of one's own vigilance.

Fatigue and sleep deprivation are probably the most common causes of lapses in vigilance. Howard et al have recommended several "fatigue countermeasures,"[51] and a 2009 IOM report has explored this in detail.[119] Such countermeasures include education about the effects of fatigue on vigilance; limiting duty hours to avoid fatigue; using good sleep hygiene (regular bedtime and wake-up time; restricting alcohol, caffeine, and nicotine use; creating good conditions for sleep); rest breaks; strategic napping; and selected medications, if necessary.

BOX 3-7

Simplified Version of Marx's Just Culture Model

Mechanisms of Breach in Duty to Patient	Description	Appropriate Response by the System[a]
Human error	An inadvertent act by a caregiver (a "slip" or "mistake")	Console the provider
At-risk behavior	Taking shortcuts: conscious drift away from safe behaviors; caregiver violates a safety rule but doesn't perceive it as likely to cause harm (the equivalent of rolling through a stop sign)	Coach the provider
Reckless behavior	Conscious choice by caregiver to engage in behavior that he or she knows poses significant risk; ignoring required safety steps	Discipline the provider

[a]Importantly, Marx noted that these responses should be independent of the actual patient outcome.

Data from Marx D: Patient safety and the "just culture": a primer for health care executives, April 17, 2001.

There is little evidence to support a specific time between breaks, but awareness of a fatigued state can suggest when a break is needed. Naps are often inconsistent with daily clinical routines but may be appropriate when routines are disrupted or during "on-call" intervals. Optimal nap times are on the order of 45 to 60 minutes to improve alertness while minimizing sleep inertia on awakening. Napping is best done when circadian rhythms enable sleep (between 2 and 6 PM and 2 and 6 AM) and is more difficult to do when circadian rhythms encourage wakefulness. The evidence that napping improves performance of flight crews is strong enough that appropriate napping is recommended during long-duration flights.[120] Providers can use caffeine judiciously to compensate for fatigue.[51] Excessive use or inappropriate timing of caffeine use can have the negative consequence of preventing subsequent sleep.

Handoffs and Transfers of Care Relief breaks, either during a procedure or at a change of shift, are a double-edged sword, providing an opportunity to identify an undiscovered problem or to create a new problem because of decreased situational awareness by the relieving provider.[55,56] Although safety experts recommended following a preplanned protocol to optimize information transfer during the handoff, much debate still surrounds our understanding of the effectiveness of such handoffs or how medical practitioners should conduct them.[58,59,121] A comprehensive review of articles published between 2002 and 2012 revealed that while clinical outcomes were not necessarily improved, information transfer was certainly enhanced.[122] A recent prospective observational study showed improved relay and retention of patient information when anesthesia providers used an electronic handoff tool; there was also improved clinician satisfaction about the quality of communication.[123]

Preparation The failure to prepare adequately for anesthesia administration often contributes to anesthesia critical incidents.[24,25,124] Preparation encompasses a large set of issues, including complete preoperative assessment (see Preoperative Assessment and Planning); ensuring availability of emergency drugs, equipment, and supplies; checking the function of equipment (especially using the recommended procedure for ensuring functionality of the anesthesia machine[125]); and ensuring communication pathways in the event of an emergency.

Preoperative Assessment and Planning Preoperative assessment and planning involve evaluation of the patient and development of the anesthesia plan, which includes the anesthetic technique, the requirements for monitoring, and the plans for postoperative care, all of which must be consistent with the wishes of the patient, the needs of the surgeon or other operator (eg, radiologist, cardiologist), and the resources of the facility. (Preoperative evaluation is considered in Chapter 5 and for specific conditions in their respective chapters throughout this text.) Similarly, an anesthetic plan must be developed that is consistent with both patient wishes and operator requirements and with the plans for postoperative care. Chapter 6 addresses the development of the anesthetic plan in detail.

Monitoring Because failure to monitor is so often associated with adverse outcomes, this issue deserves special attention. The safe practitioner follows the standards promulgated by the ASA except in truly extraordinary situations, and should those occur, he or she documents the reason for noncompliance. Critical alarms should never be disabled.[126]

Human Factors Although the individual anesthesia provider has little control over the design of equipment and local systems, he or she does have substantial control over many of the human factors features that are part of the environment. Attention to the organized arrangement of supplies and drugs, especially adherence to consistent labeling of drugs, and establishing and adhering to local standards are examples. Care to keep arterial and intravenous cannulas and monitoring cables orderly, ensuring reasonable lighting, and reducing clutter, noise, and distractions are general, sound safety practices. Control of noise levels and background music can be contentious issues among staff, surgeons, and anesthesia providers, who sometimes are urged to compromise the principle that patient safety takes preeminence. Reasonable efforts should be made to reach compromise, and music should be discontinued during management of critical events.

Teamwork Although teamwork can be seen as a subset of working within a system of care, it also includes specific practices for improving safety. A variety of health care institutions have implemented teamwork training, and there is evidence to demonstrate the effectiveness of training in improving teamwork performance and some evidence that it improves outcomes.[104] Anesthesia providers have employed crisis resource management and simulation specifically for training teamwork skills and performance (see sections that follow). There are different approaches to training, but the principles are similar. Teamwork needs should be assessed for the specific environment; all team members must be motivated and engaged in accepting the need for teamwork and agree about skills and behaviors they will adopt; health care institutions must teach and anesthesia professionals must practice and periodically reinforce these behaviors via drills and didactic sessions.[77,127] Several reports have described teamwork training programs for full operating room teams.[128,129]

The preoperative checklist developed by the World Health Organization's Safe Surgery program is specifically intended to promote teamwork and has been demonstrated to be effective in improving surgical outcomes.[130,131] All anesthesia professionals should actively and seriously participate in the preoperative briefing that uses a form of the WHO checklist.[130]

Routine Practice for Managing Emergencies Because critical events are relatively rare and demand expert and effective treatment, it is important to practice skills periodically. Schwid and O'Donnell demonstrated that advanced cardiac life support skills are generally maintained for only approximately 6 months.[132] Periodic training includes practice in management of the unanticipated difficult airway, generic skills in anesthesia crisis resource management (ACRM; see next section), and drills for operating room fires and other specific anesthetic emergencies, such as malignant hyperthermia.

Applying Systematic Crisis Management Techniques Anesthesia crisis resource management is an organized set of principles for managing crisis situations in anesthesia. Adapted by Gaba et al from crisis resource management (CRM) in aviation, it consists of several founding principles for effective management of acute events.[80,133-135] ACRM principles are a subset of teamwork training principles that are particularly focused on managing critical events. Although there is no single adopted standard, the following principles are generally applicable:

- Seek assistance early and quickly—inform others on the surgical team and call for extra assistance as soon as unusual circumstances are recognized.
- Establish clarity of roles for each person involved in management of the event; especially identify who will manage the event (event manager).
- Use effective communication processes, including reading back of instructions, being clear to whom directions are being given.
- Use resources effectively and identify what additional resources (people, supplies, equipment, transportation, etc) are available to manage the situation.
- Maintain situational awareness and avoid fixations, which are perhaps the most challenging tasks as situational awareness is difficult to retrieve once it is lost. Having one person act as event manager, observing the big picture rather than becoming immersed in the details, is thought to be effective.

Simulation has been shown to be an effective technique for learning and maintenance of CRM skills.

Simulation Increasingly, health care institutions use simulation to address many of the issues discussed in this chapter. High-hazard industries have applied simulation for years, but its applications in health care arose from pioneering work in anesthesia.[136,137] Simulation is a technique that replicates reality in ways that allow deliberate, repetitive practice for many applications. It can use technologies that represent clinical care with relatively high or low clinical, environmental, or psychological fidelity depending on the training objectives and philosophy.[138] Increasingly, health care systems use sophisticated mannequin and task trainers for high-fidelity simulation. Yet, simpler task trainers suffice for many

purposes (eg, for learning basic intubation or difficult airway management skills, skills in placing central venous catheters, regional anesthesia). There is evidence that a variety of computer-based simulators and trainers are effective for obtaining knowledge and skills for the management of acute events.[139]

For patient safety, simulation is especially useful for training novices without exposing patients to risk. As well, health care institutions can use it for periodic training for the purposes noted previously, particularly for training in the management of critical events using the CRM concepts principles. One of several models of computer-controlled mannequin is used to simulate the patient; the instructor varies the physiology, anatomy, and life signs to simulate normal or abnormal situations.[136,140] In high-fidelity simulation, institutions use props and actors to create realism, which many believe strengthen learner engagement. The early applications were for the anesthesia "crew" of the larger surgical team. More recently, simulations have involved training for entire operative teams.[129]

In addition to other skills, these CRM training sessions reinforce the concept that all team members are expected to communicate openly and without hesitation regarding safety-related matters. Examples include confirming a directive with closed-loop communication, also known as a "read back" (eg, "heparin, *xx* units, has been administered," "I'm confirming that these are Mrs. Jones's radiographs"), to speaking out when a concern for safety exists (eg, "Are you sure you should be prepping the right hand? The consent says left." or "Have you noticed that this patient's blood pressure has been falling over the past several minutes?"). Researchers have used simulation to observe baseline behaviors, practice idealized behaviors, evoke discussion about barriers and enablers of desired behavior, and measure the impact of deliberate training.[141,142] Training sessions use patient care scenarios to elicit treatment and behavioral responses from the individuals or teams being trained. Debriefing using videotapes of the session are conducted to review actions. The debriefing is critical to elicit understanding and behavior change. Debriefing skills must be learned and are challenging new behaviors for instructors who use simulation. Various techniques have been described.[138,143,144] Simulation training has been demonstrated to be effective across a variety of clinical domains for improving both clinical/technical and behavioral skills.[83,133,145-147]

Most academic anesthesia training programs now either have their own designated simulation programs or share resources with other departments in their hospitals or communities. Simulators of various types are being deployed in hospitals of essentially all types of sizes. Although there are no data on the actual numbers of simulation programs, there is a growing community of simulation professionals, evidenced by the existence of a society and journal.

The American Board of Anesthesiology highly encourages simulation training experience with both technical and behavioral crisis management practice as the preferred activity to fulfill the highest level requirement (part IV) for maintenance of certification of anesthesia credentials (MOCA).[148] There is strong evidence that participation in the program motivates positive changes in patient safety practices and anecdotal evidence of how such training has saved lives. The ASA led a process for endorsing anesthesia simulation programs that are qualified to offer that training. Currently, the simulation requirement is purely formative (ie, skill enhancing). It is likely that the experience of other industries will be repeated, and, after sufficient validation, some summative (ie, pass or fail) requirements may well be implemented. The very use of simulation is a sign of a move toward a deeper culture of safety in anesthesia and other clinical disciplines.

Cognitive Aids and Checklists Ample evidence for the benefit of cognitive aids and checklists exist in the HRO literature. In the last decade, more evidence has accrued showing the benefit of checklists and protocols in the medical literature. Within surgery, anesthesiology, and critical care, some of the pioneering work comes from Pronovost, who introduced the use of "bundles" of specific practices, organized as a checklist, to reduce central line infection rates to almost negligible levels.[149-152] Gawande expanded Pronovost's work to use checklists in surgical care, leading an international effort to develop and evaluate the impact of the World Health Organization's Safe Surgery Checklist prior to all surgical procedures.[130,131,153,154] This tool has had widespread diffusion to operating rooms internationally and has been associated with decreased surgical complication rates in particular studies. Gawande highlighted the success of checklists for complicated medical care in his popular book, *The Checklist Manifesto*, which challenges the medical community to develop more protocols for medical care that calls for complicated and timely steps to achieve high outcomes of success.[155]

Increasingly in the last decade, surgeons and anesthesiologists have shown interest in using cognitive aids during acute crisis situations.[156] Studies in the last decade reported good awareness of cognitive aids when hospitals implement them,[157] and users of cognitive aids reported that the tools help during real events.[157,158] Recently, Arriaga et al showed with high-fidelity simulation that the adoption and adherence to a surgical crisis checklist or cognitive aid increased adherence to lifesaving processes by 17%, and that a survey of study participants showed that 97% would want to have a cognitive aid or checklist if the same crisis occurred during an operation[158]; this work replicates results from previous smaller studies that demonstrated performance improvements among those participants who used cognitive aids.[159,160] Although studies have shown performance improvements using cognitive aids, anesthesiologists must still be mindful that these tools can serve as distractions and lead to other cognitive errors, particularly when diagnoses are unclear.[161]

Infection Control Care in the safe use and sterility of all anesthesia systems is essential, especially in the modern hospital environment where hospital-acquired infections with resistant organisms (eg, methicillin- or vancomycin-resistant *Staphylococcus aureus* organisms) are increasingly common. Adherence to carefully timed protocols for antibiotic administration in the perioperative interval reduces postoperative wound infection.[162] Surgical wound infection rates are increased 3-fold by hypothermia and reduced by perioperative oxygen administration.[163,164] The importance of using strict sterile technique protocols for placing central venous catheters and other venous or arterial access is now well documented: Multi-institutional studies identified contaminated stopcocks in 20%-45% of cases sampled. Peripheral intravenous cannulations may directly contribute to 6% of hospital-acquired bacteremias. Microbiological analyses have identified anesthesiologists' hands, operating room environment, and the patient as sources of contamination, and this contamination has been linked with 30-day postoperative infections and patient mortality.[152,165-168] There is simply no excuse for laxity in adherence to following prescribed protocols.

Following Standards and Practice Guidelines The ASA has established a large set of practice standards and guidelines.[169] Standardization of practices across providers is widely accepted as a critical component for safety and reliability. **Box 3-8** lists common practice standards. Each practitioner is obligated to be familiar with such guidelines and apply them appropriately in his or her practice. Similarly, health care facilities are required to establish local policies and procedures to ensure standardization of basic practices. These also must be known and followed.

INVOLVING THE PATIENT IN SAFETY AND QUALITY

Increasingly, patient advocates are encouraging patients to take a role in ensuring the safety of their own care.[170] Anesthesia professionals should embrace and encourage this concept because it benefits patient and provider alike. Providers should also be concerned with the patient's perceptions of the quality of care and consider more than just the needs of the direct surgical process. There are several ways in which these goals can be achieved.

To encourage patient involvement, anesthesia providers can take actions to foster "patient-centered communication," which has been defined as including the following[171]:

- Eliciting and understanding the patient's perspectives—concerns, ideas, expectations, needs, feelings, and functioning.
- Understanding the patient within his or her unique psychosocial context.
- Reaching a shared understanding of the problem and its treatment with the patient that is concordant with the patient's values.
- Helping patients share power and responsibility by involving them in choices to the degree that they wish to be involved.

BOX 3-8

Key Standards of Care of the American Society of Anesthesiologists

Alarm Management for Anesthesia Professionals, Statement on (2013)

Ambulatory Anesthesia and Surgery, Guidelines for (2013)

Avoidance of Medication Errors in Neuraxial Anesthesia, Statement on (2010)

Basic Anesthetic Monitoring, Standards for (2011)

Clinical Privileges in Anesthesiology, Guidelines for Delineation of (2013)

Critical Care by Anesthesiologists, Guidelines for the Practice of (2014)

Difficult Airway, Guidelines for the Management of (2014)

Documentation of Anesthesia Care, Statement on (2013)

Ethical Practice of Anesthesiology, Guidelines for the (2013)

Labeling Pharmaceuticals for Use in Anesthesiology, Statement on (2009)

Nonoperating Room Anesthetizing Locations, Statement on (2013)

Obstetric Anesthesia, Practice Guidelines (2015)

Obstetrics, Guidelines for Neuraxial Anesthesia, Guidelines for (2014)

Obstetrics Optimal Goals for Anesthesia Care (2016)

Office-Based Anesthesia, Guidelines for (2014)

Patient Care in Anesthesiology, Guidelines for (2011)

Perioperative Blood Management, Guidelines for (2014)

Postanesthesia Care, Standards for (2014)

Preanesthesia Care, Basic Standards for (2010)

Security of Medications in the Operating Room, Statement of (2013)

Data from American Society of Anesthesiologists

What specific things can anesthesia providers do to involve patients in their own care that will improve not only satisfaction but also safety? Consider the following:

- Tell the patient as much as practical (assessing how much the patient can handle knowing) about the process of anesthesia care the patient will experience.
- Provide information preoperatively about the process of anesthesia care and expectations; several references are available on the Internet in addition to books and pamphlets.
- Encourage the patient to speak up if the patient does not understand something or believes something is inappropriate, such as drugs being given, absence of hand washing or glove wearing.
- Involve the patient's family members in care whenever practical.
- Advise the patient to contact you if there are any concerns or possible side effects after the anesthetic.
- In concert with other providers, disclose errors and adverse events (a strategy that enhances trust and decreases skepticism in concerned patients).
- Involve patients on committees that are concerned with the design of anesthetizing locations and in the process of patient flow and family communication in such facilities.

SUMMARY AND CONCLUSIONS

The concepts of quality, safety, and patient-centeredness are prominent themes throughout American health care, and they have been embraced by patients and affirmed by third-party payers, specialty societies, and health care organizations, both governmental and private. Despite the increased focus on these factors, the goals have yet to be met, especially because most initiatives have focused on individual practitioners or within specific disciplines. To achieve the full goals of quality and safety, the processes must include systematic approaches that cross the boundaries of specialties, clinical services, and facilities. In short, the delivery of care must be recognized as a complex matrix of interactions among multiple providers, including both clinicians and facilities, all interacting with one another in a system of systems. The specialty of anesthesiology is a leader in the development of patient safety approaches within its discipline; the next steps involve building safety and quality into this larger system of care. Anesthesia providers can contribute significantly to achieving these goals by participating fully in the system-of-systems approach, as well as by building highly reliable microsystems within their department or group. These approaches are best understood by adopting a patient-centered approach, whereby all providers interpret the integrated care process from the patient's viewpoint and include that viewpoint in the design and delivery of care.

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CHAPTER 4

Ethics and Conflicts of Interest in Anesthesia Practice

David B. Waisel

KEY POINTS

1. Treat patients and families with the grace and consideration you would want for your family.
2. Anesthesiologists are obligated to "own" the advancement and advocacy of all things anesthesiology.

3. The goal of informed consent is to meet the patient's needs as the patient defines them. This may include providing reassurance, titrating disclosure, and following the patient's lead regarding participation in decision-making.
4. Competent patients have a virtually unlimited right to refuse potentially life-sustaining medical treatment. "Potentially" is used to emphasize the uncertainty that a treatment will be life sustaining.
5. Patients with limited decision-making capacity should participate in decision-making to the extent their capacity permits.
6. The risk of liability for honoring properly documented limitation on potentially life-sustaining medical therapy is no more than the risk of not honoring it.
7. Patients opting for goal-directed perioperative do not resuscitate (DNR) orders usually choose to authorize temporary therapeutic interventions to manage easily reversible events.
8. Physician Orders for Life-Sustaining Treatment (POLST) are medical orders valid across health care sites that comprehensively document the patient's preferred end-of-life care.
9. Clinicians face conflicts of interest in daily practice from production pressure, interactions with industry, and safety and quality care initiatives. Clinicians need to recognize potential conflicts, characterize the potential severity of the conflict, and determine the likelihood and resultant harm of the influence or the appearance of influence.
10. The discipline of medical ethics provides expertise in recognizing, analyzing, and managing ethical dilemmas.

PATIENT-CLINICIAN RELATIONSHIP

The goal of informed consent is to meet the patient's needs as the patient defines them.[1,2] This may include providing reassurance, titrating disclosure, and following the patient's lead regarding participation in decision-making.[3] Most of the time, patients want sufficient information to make substantially autonomous informed decisions. "Substantially" emphasizes that the realistic goal for consent is to sufficiently, as compared to fully, inform the patient.

COMPONENTS OF INFORMED CONSENT

Decision-Making Capacity Patients have decision-making capacity when they are capable of making a specific decision at a specific time. Patients show capacity by understanding proposed treatments, alternatives, and consequences of proceeding or not proceeding and have the ability to express a preference based on rational, internally consistent reasoning. Decision-making capacity is different from competency. The bedside clinician determines decision-making capacity for a specific decision, whereas competency is a legal determination of the global abilities required to provide legal and other authorizations.[4] Adults are presumed competent.

Clinicians should pay attention to the decision-making capacity of patients with temporary or more permanent limitations in decision-making capacity.[5] Patients with more permanent limitations in decision-making capacity should be encouraged to participate in decision-making to the extent of their abilities. Sedated patients with temporarily limited decision-making capacity should be assessed for decision-making capacity with regard to the specific decision. Decisions with riskier consequences require more comprehensive decision-making capacity. In patients with temporarily insufficient decision-making capacity, clinicians should delay nonemergent treatment until patients regain sufficient decision-making capacity.

Voluntariness Clinicians should only perform procedures on competent patients who participate willingly. Clinicians manipulate patients by distorting, downplaying, or omitting information to influence decision-making. Clinicians hinder voluntariness when they chemically or physically restrain patients who have sufficient decision-making capacity.[6] For example, in *Shine v Vega*, Shine, a competent adult, went to the hospital for treatment of an asthma attack.[7] The emergency department attending Vega recommended tracheal intubation. Shine refused. Later, Shine and her sister tried to leave but were forcibly detained. Shine was restrained, and Vega intubated her trachea. The Massachusetts Supreme Court stated that the competent patient has a right to refuse potentially life-sustaining medical treatment (LSMT), even if this decision is considered unwise.

Disclosure Disclosure is the process of supplying relevant information to the decision-maker. Skilled disclosure builds trust and facilitates patient self-determination.

The predominant legal standard in the United States is the reasonable person standard, which requires disclosure of information based on what a theoretical reasonable person would consider material for decision-making. However, the preferences of the reasonable person are not precisely defined by statute or case law.[2] Further, patients vary in their desire to receive information. Survey data indicated that 92% of patients believed that common but less-consequential risks should be discussed, and 80% of patients believed that rare but severe risks should be discussed.[8] Patient preferences for disclosure cannot be wholly predicted from socioeconomic status, age, sex, ethnicity, and history of previous surgery. Variation in clinicians' customary practices of risk disclosure indicates the complexity of using the "reasonable person" standard to guide clinical practice.[9-12]

Given that certain patients prefer either a less-extensive or more comprehensive disclosure than the typical patient, clinicians should tailor information to the patient's preferences. Clinicians do this by highlighting options that affect the perioperative experience, such as regional versus general anesthesia, and by informing patients about significant risks that the clinician considers relevant to decision-making, including how risks may vary by anesthetic technique.[1,13] Clinicians should also prepare patients for common but less-severe risks, such as postoperative nausea and vomiting. Patients should be informed whether trainees are participating in care.

To customize disclosure, clinicians may ask patients whether they want more information. For example, if there are no significant risks relevant to decision-making, the clinician can say, "There are significant but very rare risks of receiving anesthesia. Would you like me to tell you about them?" Although the likelihood of being sued based on informed consent malpractice issues is very rare, increasing satisfaction by meeting the patients' needs likely decreases complaints and lawsuits.[14] In any case, disclosure does not prevent medical malpractice liability for adverse events. Liability is based on negligence theory and depends mainly on whether the standard of care was met and if the failure to meet the standard of care was a proximate cause of injury.

The original concept of therapeutic privilege permitted physicians to withhold information if disclosure would prevent patients from making a rational decision.[15] More recently, some suggest a valid use for therapeutic privilege is to give patients' time to adjust to jarring events, to prevent stress-impaired decision-making, and to preserve hope.[16-18]

Recommendation Clinicians should highlight the advantages and disadvantages of options and recommend a plan by explaining how well each option suits the patient's preferences.

Understanding It is difficult to determine if a patient substantially understands the risks, benefits, and indications of the proposed procedures. Translating population data into data relevant and understandable to the patient is problematic. Biases affect both clinician and patient understanding of risks. In addition, patients commonly misunderstand frequently used terms, such as anaphylaxis, antibiotics, aspiration, fasting, local anesthesia, reflux, and sedation.[19]

The teach-back method has been suggested to assess patient understanding during the informed consent process. Patients are asked to articulate key information about the proposed treatment to help clinicians redress gaps or misunderstandings. In chronic disease, the teach-back method may improve disease-specific knowledge and adherence to the clinical plan.[20] It is unclear how the teach-back method would affect the acute situation of perioperative anesthesia.

Most research relating to understanding is based on the less-applicable surrogate end points of recall of information or patient satisfaction. Recalling information does not reflect the ability of patients to understand and use information, and lack of recall does not mean inadequate

understanding and use of information. Recall is generally poor.[21,22] Even the most successful interventions improve recall to only about 50% of the presented information. Written information and multimedia presentations may improve recall.[23-25] Pain and distress do not seem to compromise the ability to recall risks; treating pain tends to improve participation in the informed consent process.

Decision Patients vary in their preferences for participation in decision-making.[3,26,27] The desire to participate in the decision-making process may be a function of extent of illness, gender, age, ethnicity, social status, and level of education.[27] It is legally and ethically superior for clinicians to meet the patient's needs by tailoring participation in decision-making to the patient.[1,14]

Clinicians should obtain informed refusal when patients refuse recommendations or request a relevantly suboptimal technique. The concept underlying informed refusal is that these patients need to be more extensively informed about risks, benefits, and alternatives when they desire inadvisable techniques. Clinicians are not ethically obligated to provide care for these patients in nonemergent situations, although they may wish to assist in finding a willing colleague.

Autonomous Authorization Clinicians should seek the patient's explicit authorization to perform a specific procedure.

ISSUES IN INFORMED CONSENT

Refusing to Provide Care Society's interest in preserving the moral fabric of individual clinicians permits anesthesia providers to withdraw from care with which they morally disagree, such as the elective termination of pregnancy. Clinicians may be obligated to make a reasonable effort to find a willing colleague, although some find this recommendation ethically objectionable. Whether clinicians should perform emergent care that violates their conscience is controversial. Some argue that the altruistic obligation toward patients cannot supersede a clinician's most cherished values.[28] Others argue that medicine is foremost a service profession with obligations to society, and in extreme circumstances clinicians are obligated to put patients first.[29] This argument is rooted in the social contract the profession of medicine has with society.[30]

Clinicians may refuse to provide care only after extensive consideration and perhaps consultation with colleagues. Clinicians may not refuse to care for patients based on race, gender, or disease status, such as the patient with an infectious disease. Clinicians should refuse to provide nonemergent care if they do not feel that the environment, including their own and other clinicians' abilities, operating room capabilities, and consultative and postoperative care, provides a sufficient quality of care. Institutional policies may minimize conflict in these situations.[31]

Emergency Situations Clinicians should seek informed consent as practicable in emergency situations. The assumption is that patients want potentially LSMT. Reversibility is the key to determining how to intervene when there is incomplete evidence that the patient would prefer not to receive emergency treatment. For example, because tracheal intubation is reversible, it is appropriate to intubate the trachea of the unconscious patient when there is insufficient documentation of preferences, even if a relative declares that the patient's preferences would be to refuse tracheal intubation. Therapy may be withdrawn later if appropriate. In this case, the slight burden of temporary tracheal intubation is traded for improved clarification and certainty of the patient's wishes.

Irreversible interventions do not offer this opportunity. Consider the unconscious Jehovah's Witness patient with a critically low hemoglobin. Transfusion represents irreversible contamination. However, because the standard is an explicit refusal of potentially LSMT, clinicians should probably provide transfusion in the absence of unambiguous evidence.

Jehovah's Witness Jehovah's Witnesses interpret biblical scripture to mean that those who take in human blood shall be "cut off" from eternal life.[32] Case law unequivocally supports the rights of adult patients to refuse transfusion therapy. Physicians have not been held liable when honoring a properly documented refusal of potentially life-sustaining transfusion therapy, even in the face of maternal or fetal death.[33]

Jehovah's Witness patients consider transfusion therapy preferences as a "matter of conscience." Primary concerns center on whether it is blood from another human and whether their own blood has been outside the body. Thus, blood components, autologous blood, and banked blood are generally unacceptable. Some patients will accept blood harvested intraoperatively and returned while being kept in a closed loop, such as with cell salvage of shed blood or presurgical removal of blood. Some patients will accept recombinant erythropoietin, which depending on the brand contains small amounts of human albumin. Acceptable techniques include synthetic colloid solutions, erythropoietin-stimulating protein, and preoperative iron. Precisely documenting patient preferences forces clarification of acceptable interventions. Nonemergent care should proceed only if all clinicians are wholly certain they can satisfy the patient's requirements.

Confidentiality Clinicians are obligated to protect patient information from unauthorized and unnecessary disclosure. For example, clinicians should seek permission from patients before sharing information with family members. Clinicians should know and comply with public privacy guidelines. In particular, electronic medical and financial records may lead to inappropriate distribution of sensitive personal information.[34]

Pediatric Ethics Patients, parents, other surrogate decision-makers, and clinicians use the concepts of best interest, informed assent, and informed permission to guide decision-making about health care for minors (**Table 4-1**).[35] The best interest standard is used when the ability to apply self-determination is impossible, such as with an infant or a child with severe developmental delay. The parent or surrogate decision-maker should then apply what they believe to be in the best interests of the child, but this decision must be within an acceptable range of decision-making. Parents may not opt for grossly inappropriate overtreatment or undertreatment.[36] Whether clinicians should intervene about potentially inappropriate treatment depends primarily on the amount of harm to the child by the therapy or its absence, the likelihood of a successful therapy, and the overall risk-to-benefit ratio. Interventions include ethics consultation, legal consultation, and legal intervention.

Pediatric patients should participate in decision-making to the extent their development permits. Clinicians therefore should incorporate informed assent with older children. The extent of participation of children should increase throughout adolescence depending on the patient's maturity and the consequences of the decision. Clinicians should respect the right of adolescents not to assent to a procedure. In those cases, achieving assent may necessitate further discussions with patients, parents, and other clinicians, and such discussions may best take place away from the operating room.

Loss of confidentiality may lead adolescents to curtail or delay seeking medical care or be less forthright about information, particularly when care involves sexually transmitted infections, contraception, and mental health.[37] Clinicians may want to ask sensitive questions privately. Although clinicians should encourage adolescents to be forthright with

TABLE 4-1 Graduated Involvement of Minors in Medical Decision-Making

This broad outline should be viewed as a guide. Specific circumstances should be taken into consideration.

Age (years)	Decision-Making Capacity	Techniques
<6	None	Best interest standard
6-12	Developing	Informed permission Informed assent
13-18	Mostly developed	Informed assent Informed permission
Mature minor	Developed, as legally determined by a judge, for a specific decision	Informed consent
Emancipated minor	Developed, as determined by statutes defining eligible situations (eg, being married, in the military, economically independent)	Informed consent

their parents, clinicians should maintain the confidentiality of adolescents unless prohibited by reporting statues.[38] State statutes may limit the clinician to informing only the adolescent about a positive pregnancy test.

Emancipated minors and adolescents declared mature minors are authorized to make their own health care decisions. State statutes may award emancipated minor status to adolescents in the military, who are married, who have children, and who are economically independent. Judges may award mature minor status if the adolescent is capable of giving legal consent in a specific situation.[39-41] Judges base mature minor decisions on the maturity of the child and the consequences of the decision.

Disclosure and Apology Patients desire appropriate disclosures and apologies about medical errors.[42] On the whole, physicians and administrators agree. But fear, lack of training, and inadequate support limit the ability of physicians to disclose and apologize.[42,43]

Disclosure is a factual description of an event. An apology is an expression of sorrow, often successfully framed as a wish statement such as "I wish things were different."[44]

More than half the states have laws prohibiting the admission of apology or sympathy ("I am sorry she had to go to the intensive care unit.") as evidence of wrongdoing, but many do not prohibit the admission of disclosures of errors ("I didn't mean to miss her cardiac ischemia.").[45] The quality of these laws vary, and an apology conceivably may influence whether legal action is sought or is successful.[46,47] Sincere disclosures and apologies followed by appropriate follow-up generally improve patient satisfaction and trust, possibly forestalling legal action. Hiding or dissembling about an event infuriates patients and spurs lawsuits.

When disclosing potential errors, clinicians should be precise about communicating only what is known. It is helpful to include an expert in apology and disclosure in the conversation; if that person is unavailable, a second person in the room helps with explanations and facilitating practical matters. Clinicians should not speculate about what is not known, particularly about fault. Initial disclosure should occur promptly and should focus on the medical implications of the event. A specific permanent contact person should be identified to be the liaison for the patient and family. The contact person should be able to answer questions, arrange meetings, explain the results of the investigation, and describe the plan to prevent comparable events.

On the systems level, an approach called "disclosure, apology, and offer" discloses freely, provides fair compensation, and defends acceptable care. The goals are to increase transparency, reduce adversarial relationships, improve patient safety, and decrease legal action and costs.[48,49] The approach of disclosure, apology, and offer has decreased malpractice risks and costs, although it can occasionally prompt litigious behavior.[48-50]

For disclosure, apology, and offer to work, it needs to be practiced consistently and even-handedly. Goals and strategies need to be aligned. Physicians may shoulder more risk because settlements may need to be reported to authorities, such as the National Practitioner Data Bank. On the other hand, in some situations, hospital systems may prefer to delay compensation, hamstringing disclosure, apology, and offer and leading physicians to distrust administration. Inconsistency, favoritism, and selfishness shatter this approach.

ETHICAL AND LEGAL ASPECTS OF END-OF-LIFE CARE

The Supreme Court has grounded the virtually unlimited right of a competent patient to refuse treatment in the liberty interest of the Fourteenth Amendment, which states, "No State shall make or enforce any law which shall abridge the privileges or immunities of citizens of the United States; nor shall any State deprive any person of life, liberty or property."

For the incompetent patient, formal written or oral directives are the preferred method of directing end-of-life care. If a patient does not have declared preferences, surrogates direct care by using their judgment of what the patient would have chosen. For the never-competent patient or the opaque patient, the best interest standard is used.

A substituted interests model proposes that clinicians integrate substituted judgment and best interests.[51] Surrogates articulate the patient's values and beliefs, which is less burdensome than declaring the patient's specific preferences. Clinicians and surrogates work together to determine what would be in the best interest of the specific patient.

PERIOPERATIVE LIMITATIONS ON POTENTIALLY LIFE-SUSTAINING MEDICAL TREATMENTS

Patients have the right to limit unwanted perioperative treatment. Patients implement limitations on potentially LSMT (of which perioperative do-not-resuscitate [DNR] orders are one type) because the likely burdens outweigh the potential benefits. These patients seek interventions to reduce pain, improve vascular access and treat urgent problems unrelated to the primary disease. But, desiring these benefits does not minimize their desire to avoid potential burdens of resuscitation, such as extensive ventilatory support, cognitive deficits, or physical limitations that can follow resuscitation. "Potentially" is used to emphasize the uncertainty that a therapy will be life sustaining. The caveat of uncertainty may help clinicians communicate more successfully with patients.

The American Society of Anesthesiologists and the American College of Surgeons recommend mandatory reevaluation of DNR orders before proceeding with perioperative treament.[52,53] Most patients expect this reevaluation. Revaluation should consider the goals for surgery and end-of-life care.[54] In reevaluating the DNR order, clinicians should emphasize pertinent differences between perioperative and ward care (**Table 4-2**).

Perioperative DNR orders should be clarified and documented using the goal-directed approach.[55,56] The goal-directed approach permits patients to communicate their goals for surgery and end-of-life care in terms of outcomes. ("I do not want to suffer in the intensive care unit for my last 3 months.") Patients then authorize clinicians to use clinical judgment to determine how specific interventions will affect achieving the goals. Perioperative clinicians can weigh the etiology of the event, the effects of clinical interventions, and detailed knowledge of the goals for end-of-life care to tailor the extent of resuscitation to the likelihood of achieving those goals. To do so effectively requires attention to published literature. The viable survival rate of all patients after perioperative arrest is 25%; the application of these data to patients with limitation of potentially LSMT is uncertain given their likely more debilitated state.[57] Given the fluidity of our knowledge about successful resuscitation, the goal-directed approach promotes trials of therapy, such as cardioversion, that test assumptions about whether a therapy will achieve the patient's goals.[58,59]

Reevaluation should include determining preferences for postoperative trials of therapy. Anesthesia providers should consult with the clinicians responsible for postoperative care to ensure that those clinicians have adequate understanding of the goals of end-of-life care.

TABLE 4-2 Components of a Perioperative Do-Not-Resuscitate Discussion[55,56]

- Planned procedure and anticipated benefit
- Advantages and opportunities of having specific, identified clinicians providing therapy for a defined period
- Likelihood of requiring resuscitation
- Reversibility of likely causes requiring resuscitation
- Description of potential interventions and their consequences
- Chances of successful resuscitation, including improved outcomes of witnessed arrests compared with unwitnessed arrests
- Ranges of outcomes with and without resuscitation
- Responses to iatrogenic events
- Intended and possible venues and types of postoperative care
- Postoperative timing and mechanisms for reevaluation of the DNR order
- Establishment of an agreement through a goal-directed approach or revocation of the DNR order for the perioperative period
- Documentation

Abbreviation: DNR = do not resuscitate.

Patients opting for goal-directed perioperative DNR orders usually choose to authorize temporary therapeutic interventions to manage easily reversible events, but they reject interventions likely to result in permanent sequelae, such as neurologic impairment or dependence on life-sustaining technology.[52] For example, a dysrhythmia that responds quickly to intravenous therapy and cardioversion would be characterized as a temporary, easily reversible event unlikely to have significant sequelae. But, extended therapy would be more likely to result in unacceptable burdens and postoperative decrements in functional status. In that case, it would be appropriate to cease resuscitation. Clinicians should base decisions on continuing resuscitation on the likelihoods of outcomes; absolute certainty not only is not required but also is a standard that impairs honoring the patient's goals to avoid end-of-life burdens.

Iatrogenicity should not influence the extent of resuscitation.[60] Patients initiate limitations on LSMT to minimize potential burdens. From the patient's perspective, the outcome is relevant, not the cause. Clinicians should base the extent of the resuscitation on achieving the patient's goals.

The "temporary-and-reversible" goal-directed perioperative DNR order can be documented, for example, as the following: "The patient desires resuscitative efforts during surgery and in the postanesthesia care unit only if the adverse events are believed to be both temporary and reversible, in the clinical judgment of the attending anesthesiologists and surgeons." With the patient's permission, clinicians may want to include selected family members in the reevaluation discussion to enable the best communication of the patient's preferences.

TABLE 4-3 Barriers to Limitations on Potentially Life-Sustaining Therapy[74-78]

Anesthesiologists may care for patients who would appear to benefit from limitations on potentially life-sustaining therapy. Although the choice may be well considered, at times barriers prevent thoughtful assessment of the goals of end-of-life care. Understanding these barriers may be helpful.

Patient and Family Barriers

- Unrealistic expectations about prognosis or effectiveness of treatment
- Inadequate education/guidance from clinicians
- Guilt (often arising from minimal contact with the patient), leading to overtreatment
- Emotional overtones of "causing death"
- Stories about "miraculous" cures
- Mistrust of clinicians, hospitals, or medical system
- Personal beliefs
- Denial of death

Clinician Barriers

- No process in place for addressing end-of-life goals
- Unrealistic expectations about prognosis or effectiveness of treatment
- Inadequate communication with patient or surrogates regarding end-of-life goals
- Inadequate communication among clinicians regarding end-of-life goals
- Disagreement among clinicians about the benefit-to-burden ratio of treatment
- Influence from recent personal, hospital, or national events
- No clearly identified physician coordinating care

PHYSICIAN ORDERS FOR LIFE-SUSTAINING TREATMENT

Advance care planning enables patients to declare preferences for treatment in case they become unable to do so. Advance directives describe preferences for treatment, but are often poorly followed and are unable to capture the vagaries of complex medical care. Assigning a surrogate decision-maker through a durable power of attorney for health care decisions is often ineffective because patients do not communicate their preferences to their surrogates or surrogates may have difficulty with following through with the declared preferences.[61] Arising more than 20 years ago, Physician Orders for Life-Sustaining Treatment (POLST) have recently increased in popularity.[62] POLST may be used alone or in conjunction with other forms of advanced care planning.

Nearly all US states have or are developing a program. Programs differ slightly by state, but at the core, POLST uses medical orders to document patient preferences in a portable document that is valid across different settings. POLST documents may have several sections. In a typical POLST document,[63] the first section covers code status, such as attempt or do not attempt resuscitation; the second section covers preferences for medical interventions, such as full treatment, trial of full treatment, and selective treatment of medical conditions; the third section covers preferences for management of artificial nutrition; and the fourth section includes appropriate signatures.

The strength of POLST comes from being a medical order portable across health care sites. Because they are medical orders, POLST can affect the use and extent of emergency medical treatment. The richer guidance in POLST, as compared to documenting only code status, may lead to treatment more consistent with the patient's preferences.[64] Most surveyed clinicians felt that POLST increased the frequency and facilitated end-of-life care discussions, prevented unwanted resuscitation, are mostly stable over time, and successfully bridge settings.[65-67] A minority of clinicians reported difficulty in using the form,[68,69] addressing issues broached by POLST, transferring POLST across settings, managing family disagreements, and having time for the necessary discussions.[70,71] More research is needed to more fully appreciate the effects of POLST on bridging health care sites, directing medical care, and understanding the stability of patient preferences as described on the form.[72,73]

BARRIERS TO HONORING LIMITATIONS ON POTENTIALLY LIFE-SUSTAINING MEDICAL TREATMENT

Barriers to honoring limitations on potentially life-sustaining treatment center on clinician attitudes and inadequate knowledge about policy, law, and ethics (**Table 4-3**).[74-80] Clinicians tend to honor limitations on resuscitation in patients who are closer to dying and patients seeking palliative therapy. However, patients prioritize functional status when choosing to limit resuscitation.[60] In clinical practice, inadequate time and a lack of standardized procedures impair the reevaluation of the DNR order.

The risk of liability for honoring properly documented perioperative DNR orders is no more than the risk of not honoring it. Many states include clinician immunity provisions in statues addressing DNR orders. Immunity provisions tend to protect clinicians from liability as long as they follow statutory requirements and act in good faith.

POTENTIALLY INAPPROPRIATE TREATMENT

Treatment may be considered potentially inappropriate when the treatment may achieve the patient's goals but physicians feel that instituting treatment would be ethically inappropriate.[81] "Potentially inappropriate" is more precise than "futile," which should be reserved for situations when an intervention cannot accomplish a physiologic goal. *Potentially* indicates that determination of inappropriateness is still pending, and *inappropriate* indicates that this decision involves both value and technical judgments.

Potentially inappropriate treatment requests often arise from a breakdown of communication. Proactive communication and early involvement of expert consultation may decrease the occurrence and the intractability of these events. If a treatment conflict is unresolved after addressing communication, institutions should have a process for resolution that includes obtaining additional medical opinions and using an interdisciplinary hospital panel to review the case. Good policies are public and explicate procedures for identifying stakeholders, implementing the policy, resolving conflicts, and initiating appellate mechanisms.

PROFESSIONAL OBLIGATIONS AND MANAGING POTENTIAL CONFLICTS OF INTEREST

Conflict of interest has been defined as "a set of conditions in which professional judgment concerning a primary interest (such as patient's welfare or the validity of research) tends to be unduly influenced by a secondary interest (p. 573)."[82] Although commonly viewed as financial benefits, secondary interests also include personal and professional gains,

such as prestige, promotion, personal gratification, and respect. Conflict of interest is characterized as potential because individuals are placed in situations that create the opportunity for conflicts of interest. Clinicians need to recognize potential conflicts, characterize the potential severity of the conflicts, and determine the likelihood and resultant harm of the influence or the appearance of influence.

CLINICAL PRODUCTION PRESSURE

Clinicians face potential conflicts of interest from production pressure. Production pressure is the "internal or external pressure on the anesthesia professional to keep the OR schedule moving along speedily."[83] Production pressure can influence clinical practice by affecting the extent of preoperative discussions, the postponement of cases, the use of invasive monitoring, and the placement of catheters for postoperative analgesia. Production pressure may encourage clinicians to provide anesthesia outside their skill set or in inappropriate situations.[84] Secondary gains for clinicians may include increased referrals, positive feedback, heightened reputation, and misplaced internal pride. Clinicians should carefully consider and frequently reassess whether economic and administrative pressures induce inappropriate changes in behavior. Concerns are often best addressed by implementing systems that reduce production pressures.

INTERACTION WITH INDUSTRY

Interaction with industry is widespread and results in potential conflicts of interest for clinicians.[85-87] Overwhelming evidence indicates that intimacy with industry unconsciously affects prescribing behavior, perhaps through unrecognized feelings of gratitude, reciprocity, or obligation.[88,89] Physicians may also rationalize accepting industry gifts because of sacrifices made in terms of education, time, and compensation.[90] Physicians may legitimately claim they do not consciously adjust their clinical practice. But, consider that a core strategy of advertising is to influence unwitting patrons through familiarity and positive associations.

The claim that industry provides necessary education about the availability and use of medications is belied by the need for physicians to have unbiased information and unaffected decision-making. Although physicians supposedly independently evaluate industry information, busy physicians with insufficient abilities to critically evaluate studies devolve into accepting industry materials "as is." Industry representatives and materials routinely overrepresent the benefits and underrepresent the risks of drugs. Cynicism is the best defense.

Prohibiting relationships between academic health centers and industry is counterproductive. More appropriate goals are greater participation, the use of guidelines, and more rigorous oversight.[91] For example, in clinical trials, academic researchers should participate in trial development, have the right to examine the raw data, and be able to publish data without the company's authorization. Industry relationships with powerful members of the hospital community should be examined to determine if the potential for influence can be minimized.[87]

Relationships are examined through the Open Payments program instituted by the Physician Payments Sunshine Act of the Affordable Care Act.[92,93] This program makes public the information about financial relationships among industry, physicians, and hospitals. In the last 5 months of 2013, the Open Payments program reported data from 325,000 physicians receiving 2,430,000 payments for a value of $475,000,000. The most frequent type of payment to physicians was for food and beverage. The total value of the different types of payments varied by and within specialties.[93]

RESEARCH

Research has potential financial and nonfinancial conflicts of interest, such as the desire for advancement, prestige, and obtaining grants.[94] Research misconduct, one effect of potential conflicts of interest, occurs throughout the research cycle and includes fabricating or falsifying data, changing the design of the study to assuage the funding source, and hiding undesirable results.[95,96] In 2009, an anesthesiologist fabricated clinically influential data supporting the use of cyclooxygenase 2 inhibitors for multimodal pain therapy.[97,98] The anesthesiologist was a paid speaker for industry and received financial support for research. Supporting the benefits of oversight, irregularities found in a routine audit initiated the revealing comprehensive evaluation. Management of potential conflicts of interest may include disclosure of financial interest, independent review of research, and prohibiting relationships that create the potential for conflicts of interest. Disclosure is an inadequate remedy.[99] Physicians do not accurately disclose payments from industry during presentations of research, and it is unrealistic for clinicians to assume they can properly appreciate the influences of payments or other secondary gains.[100-103]

SAFETY AND QUALITY CARE INITIATIVES

Individual clinicians need to recognize that they have limited perspective, knowledge, and experience regarding potential medical errors.[104] Patient care obligations require clinicians to incorporate into practice hospital safety and quality care initiatives, even if they do not understand or support them. Anesthesia providers, as frontline clinicians, are also obligated to speak out. If a policy seems harmful, these clinicians should inform the appropriate individuals. Routinely bypassing the problem by ignoring the policy prevents policy remediation and hinders the effectiveness of implementing policies in general.

THE ETHICS CONSULTATION SERVICE

The discipline of medical ethics encompasses recognizing, analyzing, and managing ethical dilemmas. Ethics consultants identify relevant facts, facilitate communication, apply principles of ethical analysis, define precise ethical questions, and discover alternative, more palatable, solutions.[105,106] The law and medical ethics have different responsibilities. By defining boundaries of behaviors, the law prescribes what must be done. Medical ethics works within these boundaries to help determine what ought to be done, to recognize when to challenge boundaries, and to provide guidance in areas not governed by law.

Ethics consultations are typically performed by an individual, a small group, or a full committee. Ethics committees seek to have a heterogeneous membership that spans the hospital and may include physicians, nurses, social workers, chaplains, administrators, and laypeople. There are burgeoning attempts to develop and use a quality assessment tool for ethics consultants.[107] Most ethics consultation services permit patients, families, and those participating in the care of the patient to request a consultation. The standard of care is that ethics consultation services have no formal authority and are only advisory. Outcome data are sparse; most research is being used to develop evaluation instruments.[108]

Ethics consultation is helpful with questions about informed consent, decision-making capacity, and resuscitation decisions and resolving disagreements among patients, families, and caregivers.

PROFESSIONAL OBLIGATIONS

Anesthesiologists have overlapping professional obligations to patients, the local community, anesthesiology, and societal health (**Table 4-4**).[109-113] It is fashionable to bemoan the financial and clinical fate of physicians. Among other legitimate and illegitimate complaints are these: Physicians are paid too little and work too hard, are forced to assume untenable loans, and are being treated like technicians. These issues are irrelevant in terms of the physician's obligation to fulfill the social contract. Society invested limited resources to develop the medical infrastructure of education, materials, expertise, and opportunities that enables physicians to practice. Despite these concerns, medical practice still provides significant compensation, official authority, unofficial influence, and the exquisite privilege of making a difference in individuals and society. In exchange for these considerable privileges, the implicit social contract calls for physicians to use their professional skills altruistically to better society.

Anesthesiologists are obligated to "own" the advancement and advocacy of all things anesthesiology.[114]

TABLE 4-4 Obligations of Anesthesiologists

Physicians are obligated to their communities. Community may be considered broadly to be a physical location, a type of patient, or groups with whom physicians electively associate. Here is one perspective of communities to which anesthesiologists are obligated. Individual anesthesiologists are not expected to fulfill every obligation. Units of anesthesiologists such as private practice groups, academic departments, and state societies should fulfill these obligations collectively.[112-114]

Patient Community	Local Community

• **Treat every patient with the grace and consideration you would want for your family**
• Tailor the perioperative experience to the individual
• Respond to problems that may harm patients (eg, impaired colleagues)
• Practice mindfulness and critical self-reflection
• Actively engage in continuing medical education
	• Foster patient safety
	  • Participate in surveillance data collection
	  • Comply with policies intended to improve care
	  • Seek best practices
	  • Participate in collaborative care
	• Participate in hospital governance
	• Build hospital systems that improve patient care (eg, sedation services, preoperative clinics, pain management services)

Society	**Anesthesiology Community**
• Be politically active • Participate in social advocacy of an area of choice (eg, tobacco use, socioeconomic disparities in general and in health care, health care delivery) • Support national and international health care missions	• Teach, do research, or support teaching and research • Participate in professional organizations related and unrelated to anesthesiology • Prepare future generations through mentoring, creating opportunities, and designing practice styles that encourage participation

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PART 2

Preparing for Anesthesia

CHAPTER 5

Overview of Preoperative Assessment and Management

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KEY POINTS

1. Anesthesiologists function as perioperative consultants when the entire spectrum of perioperative care is examined, not solely the intraoperative period, and interventions are implemented to improve overall outcome.
2. Risk assessment tools are used to quantify risk and provide a common language for communication with patients and colleagues.
3. The medical history and physical examination are the cornerstones of preanesthetic assessment. Preoperative investigations are indicated to diagnose disease based on known risk factors or to evaluate the current state of an existing disease.
4. "Routine" or "screening" preoperative tests are not indicated, as they are costly and seldom provide useful information.
5. At-risk patients are best assessed prior to the day of surgery to allow adequate time for assessment and implementation of indicated risk reduction strategies. At-risk patients may include those with
   a. Cardiovascular disease: hypertension, ischemic heart disease, coronary stents, valvular disease, heart failure, rhythm disturbances, cardiovascular implantable electronic devices
   b. Respiratory disease: reactive airways disease, chronic obstructive pulmonary disease, pulmonary hypertension, upper respiratory tract infection, smokers, obstructive sleep apnea
   c. Significant systemic disease: obesity, diabetes mellitus, renal disease, hepatic disease, anemia, neurologic disease, cancer, thromboembolic disorder
   d. Substance abuse
   e. Anesthesia-specific concerns
   f. Ambulatory surgery
6. Consultation with other physicians should seek specific advice regarding the diagnosis and status of a patient's condition or the creation of a clinical risk profile. "Preoperative clearance" is seldom helpful and should not be requested.
7. Evidence-based practice guidelines minimize cancellations or delays on the day of surgery resulting from individual practice variation. Liberalized fasting guidelines permitting consumption of clear fluids until 2-3 hours preoperatively are safe and minimize patient discomfort.
8. Preanesthetic assessment in clinic by an anesthesiologist prior to surgery improves patient satisfaction and alleviates anxiety; avoids medicolegal culpability resulting from inadequate assessment or unnecessary testing; and is economically beneficial by minimizing preoperative testing and avoiding case cancellations or delays.

THE ANESTHESIOLOGIST AS PERIOPERATIVE CONSULTANT

As the practice of medicine becomes increasingly outcomes driven and cost conscious, the role of the anesthesiologist as a perioperative consultant continues to evolve. No other specialty is more uniquely positioned or well suited to coordinate overall perioperative care than anesthesiology. The cornerstone of perioperative management is the preanesthetic assessment, a snapshot of a patient's overall physical status that allows for risk assessment for an upcoming surgical procedure and implementation of risk reduction strategies. Whether performed weeks in advance of the procedure or immediately prior, this information-gathering session serves to detect and evaluate disease through the medical history, physical examination, and review of investigations and findings. Certain at-risk populations will benefit from intensive planning and therefore may benefit from assessment in advance of the procedure to allow for time to implement management strategies. Perioperative patient management may include consultations with other physicians, application of relevant practice guidelines, discussion of appropriate fasting recommendations, providing instructions for medications, and postoperative disposition planning. The evolving role of the anesthesiologist demands attention to the entire continuum of perioperative care, not solely the intraoperative period, with the aim of improving overall outcome for the patient's surgical procedure. The concept of a perioperative surgical home has existed in many forms for several decades; however, it has only recently become a focus of attention as a way to streamline costs and improve operating room efficiency.[1-4] The consultant anesthesiologist, working through a centralized perioperative medicine clinic, is a key player in this process.

Not all patients require assessment in a perioperative clinic in advance of surgery. To ensure effective resource utilization, patients may be triaged based on American Society of Anesthesiologists (ASA) physical status, comorbid conditions, screening questionnaires, or procedure complexity. Factors that are considered in triaging complex patients likely to benefit from assessment in a perioperative clinic include the following:

1. Screening and management of comorbid conditions in at-risk populations.
2. Assessing the need for surgical risk assessment.

3. Identifying patients requiring special anesthetic techniques or postoperative care, including specialized pain management strategies.
4. Establishing a baseline for anesthetic planning.
5. Educating patients and families about expectations surrounding anesthesia care.
6. Obtaining informed consent.
7. Facilitating timely care and avoiding day-of-surgery cancellations by managing anesthesia workflow.
8. Determining patient appropriateness for ambulatory surgical facilities or remote locations.
9. Motivating patients to stop smoking, lose weight, or commit to other preventive care.

Table 5-1 outlines the criteria and medical conditions of patients likely to benefit from evaluation in a perioperative medicine clinic before the day of surgery.

Whether occurring in a perioperative medicine clinic or immediately prior to surgery, the ASA has indicated in a practice advisory that a preanesthetic assessment should include the following content[5]:

1. Readily accessible medical records
2. Patient interview
3. A directed examination (including an assessment of the airway, lungs, and heart, at a minimum)
4. Preoperative tests when indicated
5. Other consultations when appropriate

Effectively triaging patients for assessment in clinic and ensuring adequate evaluation improves patient satisfaction with anesthesia, avoids unnecessary medicolegal culpability (see Medicolegal Culpability section), and improves operating room efficiency and economics (see Economics section). In addition, perioperative medicine clinics provide opportunities for behavioral modification intervention at a "teachable

TABLE 5-1 General Criteria and Medical Conditions for Which Preoperative Evaluation Is Recommended Before the Date of Surgery

Medical Condition	Criteria
General	Age
Normal activity inhibited	>75 y, unless surgery is minor (eg, cataract, cystoscopy) and under monitored anesthesia care
Monitoring or medical assistance at home within 2 mo	Language
Hospital admission within 2 mo	Patient or parent/guardian cannot hear, speak, or understand English
Obesity > 140% ideal body weight	Anesthesia related
Cardiovascular	Patient or family has had previous difficult intubation or elevated temperature during anesthesia, is allergic to succinylcholine, has had malignant hyperthermia or pseudocholinesterase deficiency or paralysis or nerve damage during anesthesia
Coronary artery disease	Procedure related
Arrhythmias	Intraoperative blood transfusion likely
Poorly controlled hypertension	ICU admission likely
Systolic blood pressure > 180 mm Hg or diastolic blood pressure > 110 mm Hg	High-risk surgery
Heart failure	Pregnancy
Respiratory	Patient is pregnant (unless the procedure is termination)
Asthma requiring daily medications	
Chronic obstructive pulmonary disease (COPD) with symptoms	
Exacerbation or progression of COPD within 2 months	
Previous airway surgery	
Unusual airway anatomy	
Airway tumor or obstruction	
Home ventilatory assistance or monitoring	
Endocrine	
Diabetes	
Adrenal disorders	
Active thyroid disease	
Neuromuscular	
Seizure disorder	
Central nervous system disease (eg, multiple sclerosis)	
Myopathy or other muscle disorders	
Hepatic	
Active hepatobiliary disease or compromise	
Renal	
Renal insufficiency or failure	
Musculoskeletal	
Kyphosis or scoliosis compromising function	
Temporomandibular joint disorder limiting mouth opening	
Cervical or thoracic spine injury/disease	
Oncology	
Chemo- or radiotherapy within last 2 months	
Significant physiologic compromise from disease or treatment	

Adapted with permission from Pasternak LR: Preoperative evaluation of the ambulatory surgery patient, Ambulatory surgery. *Anesthesiol Rep*. 1990;3(1):8.