Chapter 18
Patient Safety in Anesthesia

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> *"We often discover what will do, by finding out what will not do; and probably he who never made a mistake never made a discovery."*
>
> Samuel Smiles

Introduction

The field of anesthesiology has had a long relationship with issues related to patient safety. Early practitioners recognized that the administration of anesthetic agents was fraught with danger for patients, and some of the initial large-scale studies aimed at examining rates of morbidity and mortality in medical practice focused on surgery and anesthesia [1]. For the period spanning the 1950s through the 1970s, estimates of mortality caused by anesthesia care itself attributed one or two deaths to every 10,000 patient encounters. It was not until the late 1970s, however, that the sources of human error and mechanical malfunction leading to patient injury were analyzed in depth. In 1978, Cooper et al. employed the critical incident analysis technique developed in the aviation industry to examine the etiology of human errors in anesthesia mishaps. He and others later expanded on this work to suggest how hospital systems could be improved to minimize risks to patients [2].

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Faced with mounting costs of professional liability insurance in the mid 1980s, the American Society of Anesthesiologists (ASA) became the first major professional society to champion the cause of patient safety. In 1985, the Anesthesia Patient Safety Foundation (APSF) and the ASA Closed Claims Project were created. The APSF was charged with raising awareness of patient safety issues and creating programs to address problems identified [3]. The Closed Claims Project was designed to collect and analyze data from closed insurance claims to identify sources of patient injury [4]. In 1984, Harvard Medical School voluntarily imposed standards for patient monitoring during the administration of anesthesia at all of its teaching hospitals, which were used as a model for more comprehensive standards adopted by the ASA in 1986 [5]. Importantly, these standards required some means of continuously monitoring ventilation and circulation, which had become more feasible with the introduction of new technologies such as capnography and pulse oximetry.

With this emphasis on patient safety, clear improvements were seen in the following decades. Analysis of closed claims has revealed a significant drop in death and brain damage as a cause for legal action against anesthesiologists [6]. The ASA continues to seek improvements in patient safety. In the past 5 years, dozens of standards, guidelines, and statements have been published with intent of improving outcomes [7]. Moving forward, the specialty of anesthesiology will continue to maintain its position as a leader in patient safety and improvements in care.

Case Studies

Case 1: The Impaired Anesthesiologist

Timeline

2:30 a.m.: An alarm on a pulse oximetry sensor alerts the nursing staff in the Post Anesthesia Care Unit (PACU) to a patient in distress.

2:33 a.m.: After assessing the patient and recognizing respiratory distress, the nursing staff administers oxygen and pages the senior resident on call.

2:38 a.m.: The resident does not respond to the page, and the patient's oxygen saturation levels are continuing to range from 78 to 86 %. The senior anesthesia resident is paged overhead to the PACU. Following no response, the nurse pages the junior anesthesia resident.

2:40 a.m.: The junior anesthesia resident on call reports to the PACU and finds the patient disoriented and making poor respiratory effort. After inquiring as to the whereabouts of the senior resident, the junior resident decides to intubate the patient on his own. The intubation is performed successfully, and subsequent pulse oximetry and arterial blood gas measurements confirm the stabilization of the patient.

3:15 a.m.: The junior resident locates the senior resident in the call room. The senior resident is sleeping and is difficult to arouse. Upon awakening, the senior resident is groggy and incoherent. There are empty vials of fentanyl and used syringes on the floor next to the bed.

7:00 a.m.: The junior resident notifies the Operating Room (OR) director of his senior resident's behavior, and the senior resident is confronted about suspected substance abuse. The resident confesses to injecting himself with fentanyl he had collected during cases the prior day.

7:30 a.m.: The program director is made aware of the situation. A urine sample is requested, and plans are made to immediately suspend the resident and arrange for substance abuse treatment.

While in treatment, the resident admits to having been abusing fentanyl for 6 months prior to the on-call incident. He identifies the stress of a recent divorce as a potential trigger for his descent into addiction. He claims he obtained fentanyl by administering less to his patients than he was charting and saving the excess. He would sometimes use β (beta) blockers to mask the physiologic signs of inadequate anesthesia. When inquiries were made into signs of abuse that might have been missed, other residents in the program were incredulous. They described this person as hyperconscientious and hardworking. They reported that he would often volunteer for extra call and decline relief for breaks.

Analysis of Root Causes and Systems in Need of Improvement

The proximate cause of danger to patients under the care of this resident is clear. By injecting himself with a psychotropic medication while charged with supervising patient care, he was jeopardizing both his and patients' safety. All patients, but particularly patients in an intensive care setting, require vigilance and lucid decision-making. Had the junior resident been unable to respond appropriately, the consequences could have been catastrophic. Altered clinical decision-making capacity is a critical threat to patient safety.

The root causes, however, beyond this individual's breach of duty, lie in inadequate systems to prevent this from happening and being detected. The incident raises questions of how this resident was able to obtain narcotics and how his abuse of them continued in the workplace without raising the suspicion of his colleagues.

This particular resident admitted to obtaining fentanyl by charting its use, but administering less to his patients in the operating room. Subsequent review of his medication usage revealed a consistent pattern of using quantities of narcotics in excess of what would be typical for given procedures. He also admitted to several instances of withdrawing medications from Pyxis® machines remote in time and location from cases to which he was attributing them. Had a more rigorous system to track medication usage been in place, the department may have been alerted to these red flags.

Discussions with this resident's colleagues uniformly revealed shock and disbelief regarding their co-resident's addiction. In hindsight, he displayed behavior that could have been identified as subtle warning signs. Other residents described this individual as hardworking and hypervigilant. He would frequently volunteer for extra shifts and refuse relief for breaks. Some noted him to have become more withdrawn, but they surmised he was trying to deal with his divorce privately and did not wish to overstep the bounds of their professional relationship. If the residents had been more keenly aware of behaviors suggestive of substance abuse they might have been more inclined to intervene.

This program also did not employ routine drug screening for its residents. Faculty perceived this kind of action as intrusive and worried residents would balk at what might be considered an invasion of privacy.

Discussion

Due to the ready availability of many medications with high potential for abuse, physician impairment has been identified as a possible hazard of anesthesia practice. The specialty tends to be overrepresented in substance abuse treatment programs compared to its contribution to the total pool of physicians. In 1987, Talbott et al. [8] examined data from the first thousand cases referred to the Medical Association of Georgia's Impaired Physician Program. They reported that anesthesia residents made up 33.7 % of those who presented for treatment while comprising only 4.6 % of residents in the state. While not as exaggeratedly, disproportionate rates of substance abuse appear to continue after residency. In 2009, Skipper et al. [9] analyzed data from 16 state physician health programs and excluded resident physicians from their analysis. Anesthesiologists represented 11.1 % of those enrolled in these programs, but accounted for only 4.1 % of physicians at that time. This study also showed anesthesiologists are much more likely to abuse intravenous narcotics than practitioners in other fields.

An impaired physician in the OR presents an obvious risk to patient safety. In spite of this risk, an analysis of closed claims in 1994 found substance abuse mentioned in only a small number of claims against anesthesiologists [10]. Still, these claims represent only instances when a patient has been demonstrably harmed due to substance abuse. Many cases where harm is less obvious or physician impairment has been overlooked likely go unreported. For example, scenarios involving inadequate analgesia or cardiovascular complications from patients not receiving narcotics due to anesthesiologists diverting drugs for personal use could be difficult to prove.

Not to be overlooked are the dangers to the anesthesiologist himself. Anesthesiologists have been found to have a relative risk of drug-related death of 2.79 (CI = 1.87–4.15, $P < 0.001$) when compared to general internists, with the highest risk of death occurring in the first 5 years of training [11].

Recognizing the issue of substance abuse in the anesthesia workplace, departments and institutions have developed ways to combat the problem. Efforts to prevent addiction have focused on drug control and education [12].

Easy access to narcotics and other potentially addictive drugs has logically been identified as a risk factor for substance abuse in anesthesiology [13]. Therefore, efforts have been made to restrict and monitor this access. The cornerstone of these efforts is detailed record keeping [14]. Records of medication usage can then be analyzed for patterns suggestive of drug diversion. Such patterns include high usage and wastage, transactions that occur at automated dispensers not located at the site of indicated use, and drugs obtained for completed, nearly completed, or canceled cases. Increasingly, automated systems are being developed to audit anesthesia records for these red flags [15]. Additionally, pharmacies now routinely screen returned wasted drugs to verify their contents [12].

Anesthesia departments have also instituted education programs aimed at highlighting the dangers of substance abuse and the importance of recognizing and reporting abuse in colleagues. Residency programs are now required by the Accreditation Council for Graduate Medical Education (ACGME) to have a substance abuse education program in place [16]. Residents are taught to identify behavior patterns that could easily be dismissed or thought unremarkable. More obvious signs of abuse include emotional lability, erratic behavior, and social withdrawal, but less glaring warnings are also highlighted. These include efforts on the part of the abuser to obtain and mask his addiction that are often interpreted as a strong work ethic. Substance abusers will often volunteer for extra call, decline relief breaks, or take frequent bathroom breaks [17]. Importantly, all members of the healthcare team must feel empowered to speak up about concerns, and lower ranking team members should not fear repercussions or reprisal for reporting suspected abuse [18].

Another potentially contentious method of identifying abuse is drug screening of those with access to narcotics. Use of random toxicology screening is not routinely employed due to reluctance to subject all personnel to what is perceived as an invasion of privacy. While many anesthesia departments have adopted drug screening, it is still more commonly used to confirm cases of suspected abuse.

While prevention is preferable to treatment of abuse that is ongoing, departments must be prepared to deal with abuse when it is discovered. The ACGME requires residency programs to have written policies in place to deal with cases of abuse [17]. Many states allow professional societies to divert impaired healthcare professionals into treatment and rehabilitation programs without the notification of licensing boards. Some degree of confidentiality is guaranteed contingent on successful completion of rehabilitation and compliance with all treatment requirements [19]. Unfortunately, the success rates of rehabilitation programs are low, and returning to the workplace often endangers patients and the returning physician. Relapse is all too often only discovered with the death of the anesthesiologist returning to practice [20]. Several authors have recommended redirection of anesthesiologists with substance abuse problems into other specialties with less access to narcotics [21, 22]. The decision to allow reentry should be made on a case-by-case basis, and when reentry is attempted, close monitoring with gradual reinstatement is advised [23]. The impaired physician highlights the duality of patient safety and its impact on the health system, its providers as well as its consumers.

Case 2: Errors in Airway Management

Timeline

7:00 a.m.: An anesthesiologist working in a freestanding ambulatory surgery center conducts his preoperative evaluation in the holding area for a 54-year-old male scheduled to undergo an elective inguinal hernia repair. The patient's only medical problem includes hypertension controlled with Enalapril. The anesthesiologist notes he is mildly obese (BMI 33) and has a short thyro-mental distance. Range of motion of the cervical spine and at the atlanto-occipital junction is fully intact. There are no issues with dentition. The Malampati score (a scaled score of 1–4 evaluating potential difficulty for intubation) is determined to be 3 [24]. *The patient reports that his wife tells him he snores loudly, but has never seen a doctor for sleep apnea. He has a prior history of surgery for a broken humerus during a skiing accident. He remembers being kept overnight, but when asked if he was told about any complications from anesthesia he does not remember. He thinks his wife would remember better, but she is outside on the phone talking to their son. The anesthesiologist leaves before the patient's wife returns.*

7:35 a.m.: The patient is brought to the room, monitors are placed, and preoxygenation is begun.

7:40 a.m.: Anesthesia is induced with midazolam, lidocaine, fentanyl, and propofol. Rocuronium is administered immediately following induction to ease intubation and provide paralysis for surgery.

7:42 a.m.: The anesthesiologist attempts to intubate with a size 7.0 endotracheal tube (ETT), but is unable to do so. He switches laryngoscope blades and makes another unsuccessful attempt to intubate the patient. He then asks the circulating nurse to place a shoulder roll under the patient and tries to intubate with a smaller tube, but now notices new-onset edema of the airway. He attempts to ventilate between intubation attempts, but the oxygen saturation drops to 70 %.

7:46 a.m.: After unsuccessfully attempting intubation with the smaller ETT the anesthesiologist now finds it increasingly difficult to ventilate the patient. The anesthesiologist asks the nurse to call for help and for the fiberoptic intubating endoscope.

7:52 a.m.: Help has not yet arrived, and the patient is now nearly impossible to mask ventilate. The patient's oxygen saturation levels have dropped into the teens, and he is bradycardic. After placing folded sheets to ramp up patient's head, the anesthesiologist makes a final unsuccessful attempt to intubate using a Miller laryngoscope and asks the surgeon to prepare for a surgical airway. The patient is hypotensive, bradycardic, and oxygen saturation is not accurately sensing.

7:54 a.m.: As the surgeon is to begin an invasive airway, another anesthesiologist arrives with a fiberoptic intubating endoscope. The scope is passed successfully through the patient's vocal cords and used to guide the placement of a size 6.5 ETT.

7:59 a.m.: The patient's vital signs stabilize, and all believe that the crisis has been averted. The decision is made to proceed with the case.

9:20 a.m.: At the conclusion of the case efforts are made to arouse the patient, but even after no inhaled anesthetics are detectable in the patient's expired air he is unresponsive.

This incident resulted in anoxic brain injury, and the patient remains in a persistent vegetative state. When the wife was informed she recalls being told after her husband's previous surgery that there was some difficulty with intubation. She had assumed this information would be in his chart or that her husband would have known to make his anesthesiologist aware of this.

Analysis of Root Causes and Systems in Need of Improvement

This case exemplifies a scenario every anesthesiologist dreads. Securing the patient's airway during the induction of anesthesia is one of the anesthesiologist's most crucial responsibilities. Yet the overwhelming number of uneventful inductions may lead to lapses in vigilance and preparedness. This principle extends more broadly to the practice of anesthesia, where catastrophe must always be anticipated in spite of its infrequent occurrence.

The failures of the anesthesiologist in this case center on his lack of preparedness, beginning with not recognizing a potentially difficult airway. Several elements of this patient's preoperative history and physical exam should have alerted the anesthesiologist to this possibility. These include obesity, short thyro-mental distance, snoring, and most importantly, the patient's reference to previous complications. When asked to explain his decision not to clarify the patient's history with the patient's wife, the anesthesiologist reported being concerned about delaying the start of the case. In this way, financial concerns and perceived pressure from colleagues to proceed with cases can supersede proper regard for patient safety. This may be particularly true in a private practice setting.

As in nearly all cases of patient injury, the responsibility does not lie solely on the shoulders of the individual practitioner. Records of this patient's previous operative and postoperative course at an outside institution were not readily available to the anesthesiologist. Nor was there any system in place to alert subsequent providers to previous airway difficulties. Better interprovider information sharing may have prevented this incident, but benefits must be weighed against possible breaches in the security of protected health information.

Had this anesthesiologist anticipated a difficult airway, he might have altered his management plan. Standard induction protocols involve rendering the patient apneic before placement of the endotracheal tube. When faced with a high likelihood of difficulty securing a patient's airway, anesthesiologists will use modified protocols that avoid this situation. The anesthesiologist may have considered intubating this patient while he was still awake or using regional anesthesia, obviating the need for intubation altogether.

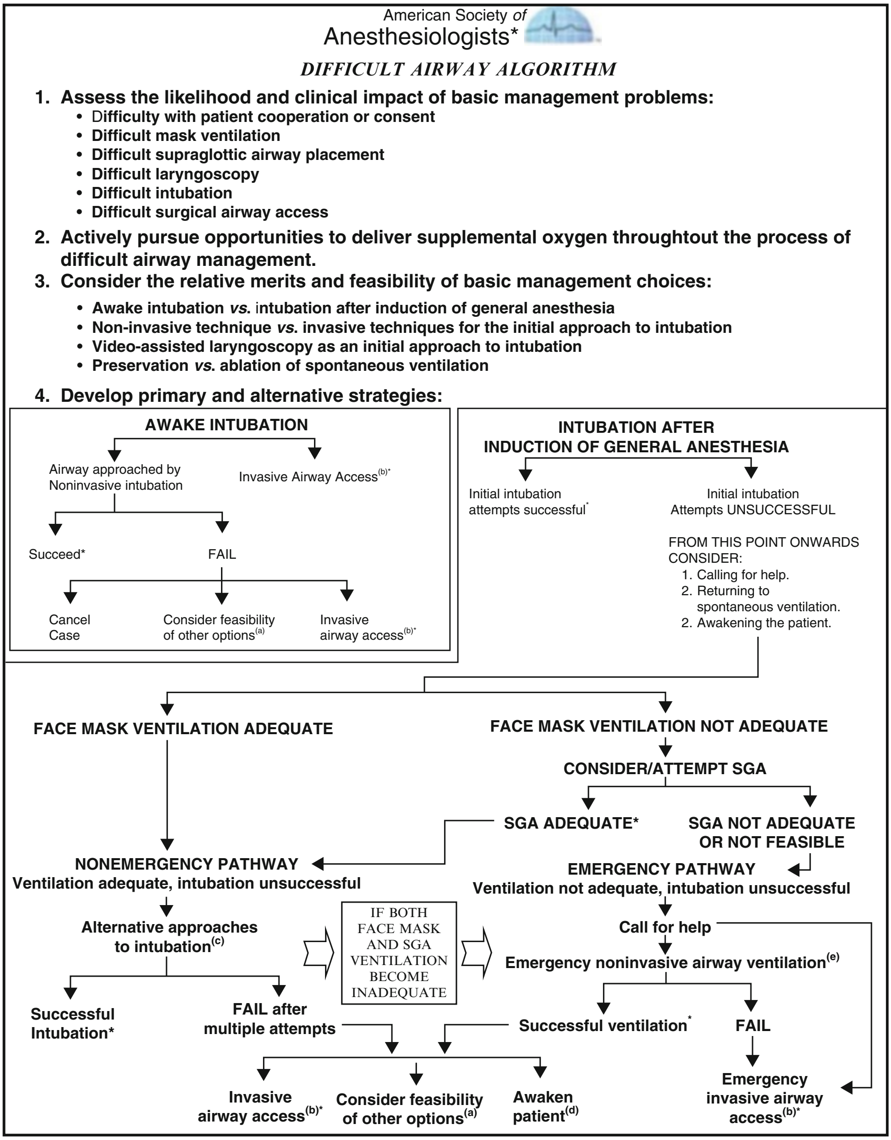
Beyond his failure to foresee difficulty, this anesthesiologist can also be faulted for ignoring the most current practice guidelines. These guidelines urge anesthesiologists to have a preformed plan for the possibility of a difficult intubation, including having rescue devices available should direct laryngoscopy fail. The anesthesiologist admitted to not feeling comfortable using some of the newer devices that are now available, having never been trained on them. In this way, he and his employer allowed suboptimal care to be delivered to their patients by not incorporating advancements in technology and techniques into their practice. It is all too easy to become complacent with one's level of training upon completing residency. Individual practitioners and provider organizations must develop ways to ensure that education and training continue throughout anesthesiologists' careers.

Discussion

Respiratory system adverse events have historically been a major source of anesthesia malpractice claims. A 1990 analysis of closed claims found this type of injury to account for 34 % of claims, with 85 % of those resulting in brain damage and death. The authors noted that 17 % of respiratory events were rooted in difficult intubations [25], highlighting an area of concern. Recognizing the need to improve outcomes, the ASA developed practice guidelines in 1992 for managing difficult airways, which were updated in 2013 [26]. Other common sources of respiratory events identified in the 1990 study were inadequate ventilation and undiagnosed esophageal intubation, which were already being addressed with improved monitoring standards. Recent analyses of closed claims data show that with these improvements in place, the incidence of death and brain damage has declined significantly since the 1980s. Between 1990 and 2007, respiratory events were identified as the cause of 17 % of claims [6].

The ASA's guidelines recommend evaluation of the airway by history, physical examination, and, in certain cases, attempting to gather additional information. The single most important piece of information a patient can provide is a history of difficult intubation [27]. Unfortunately, patients are often unaware of a history of difficult intubation or the importance of conveying this information. Some institutions have developed policies to alert subsequent providers to a history of difficult intubation through a variety of means. Proposed methods for interinstitution communication of this information have included alert bracelets, registries [28], and wallet-sized identification cards [29].

Borrowing from the successful use of algorithms in the management of life-threatening cardiac events, the ASA has developed algorithms to illustrate key decisions points in the approach to a difficult airway (Fig. 18.1) [26]. The initial steps of the Difficult Airway Algorithm are designed to encourage practitioners to develop a preformed plan for each case. Inevitably, preparation will occasionally fail and patients will unexpectedly prove impossible to intubate and ventilate by face mask. Still, the anesthesiologist is not without recourse before resorting to an invasive



*Confirm ventilation, tracheal intubation, or SGA placement with exhaled co_2.

a. Other options include (but are not limited to): surgery utilizing face mask or supraglottic airway (SGA) anesthesia (e.g., LMA, ILMA, laryngeal tube), local anesthesia infiltration or regional nerve blockade. Pursuit of these options usually implies that mask ventilation will not be problematic. Therefore, these options may be of limited value if this step in the algorithm has been reached via the Emergency Pathway.

b. Invasive airway access includes surgical or percutaneous airway, jet ventilation, and retrograde intubation.

c. Alternative difficult intubation approaches include (but are not limited to): video-assisted laryngoscopy, alternative laryngoscope blades, SGA (e.g., LMA or ILMA) as an intubation, conduit (with or without fiberoptic guidance), fiberoptic intubation, intubating stylet or tube changer, light wand, and blind oral or nasal intubation.

d. Consider re-preparation of the patient for awake intubation or canceling surgery.

e. Emergency non-invasive airway ventilation consists of a SGA.

Fig. 18.1 American society of anesthesiologists difficult airway algorithm. With Permission from Anesthesiology. 2013; 118:251–70

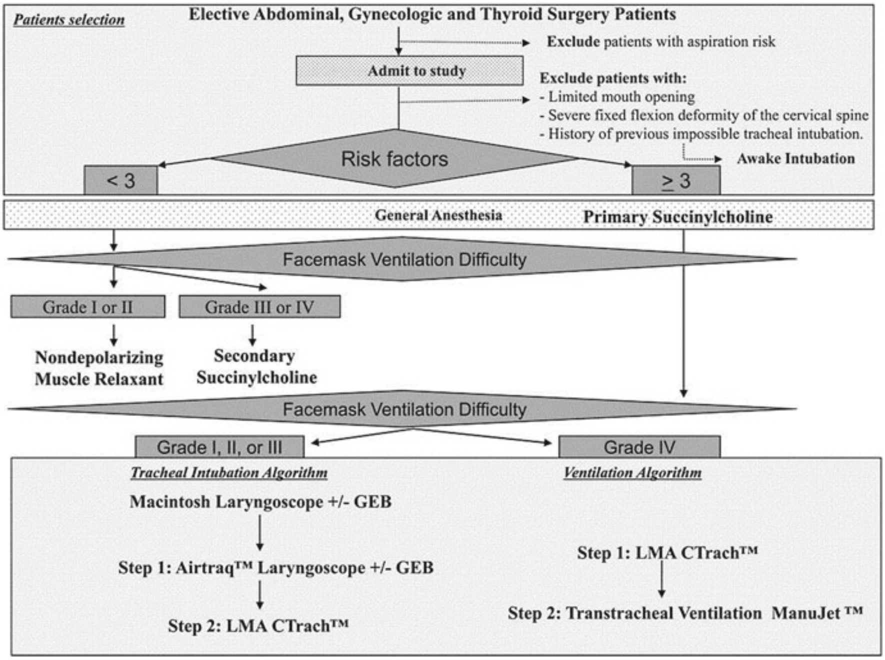


Fig. 18.2 Decision tree for muscle relaxant choice and airway management. The difficult ventilation grading scale is the following: Grade I, ventilation without the need for an oral airway; grade II, ventilation requiring an oral airway; grade III, difficult and unstable ventilation requiring an oral airway and two providers, or an oral airway and one provider, using mechanical ventilation (pressure-controlled mode); and grade IV, impossible ventilation. *GEB* gum elastic bougie. Reprinted with permission from Anesthesiology. 2011; 114(1):25–33

surgical airway. For supraglottic obstructions, the placement of a laryngeal mask airway (LMA) can often be used to restore adequate ventilation. An increasing number of devices are available to assist with nonemergent intubations. With the use of newer optical devices and other tools for intubation becoming more widespread, European authors have reported success with a modified algorithm (Fig. 18.2) [30].

With the omnipresent risk of catastrophe, those involved in the education of anesthesiologists have sought ways to heighten the readiness of practitioners for uncommon, but critical events. Borrowing from other industries with similarly routine, but risky situations, simulation was introduced into the training of anesthesiologists beginning in the late 1980s [31]. Simulation training is now commonly used at all levels of education in anesthesiology, particularly in residency programs to develop a broad set of skills. These skills range from procedural and technical proficiency to team communication and reinforcement of protocols for rare events. While simulation seems intuitively well suited to training in these areas, its efficacy is difficult to prove. However, a growing body of evidence is supporting its use. The efficacy of simulation in the teaching of procedural skills is most easily measured and well supported [32]. It is more difficult to show improvement in performance in complex situations, such as team training [33]. However, anesthesiologists have reported feeling strongly influenced by simulator training when rare emergencies have been encountered subsequent to simulator preparation [34]. What is certain is that simulation training is gaining acceptance and its use will continue to grow.

Conclusion

Anesthesiologists have served as pioneers in the medical profession embracing the principles of patient safety. Complications from anesthesia have declined dramatically over the last 50 years, and patient outcomes have improved. While perioperative deaths attributed to anesthesia were approximately 1 in 1,500 some 50 years ago, today that number has improved nearly tenfold; that is a dramatic increase in patient safety despite older and sicker patients being treated in operating rooms nationwide. At present, the chances of a healthy patient suffering an intraoperative death attributable to anesthesia is less than 1 in 200,000 when an anesthesiologist is involved in patient care. Therefore, vigilance and integrity coupled with medical knowledge and clinical skills are at the forefront of an anesthesiologist's goal in providing safe anesthesia care.

Key Lessons Learned

Case 1

- Physician wellness is an essential element of patient safety.
- While individuals are responsible for maintaining a state of physical and mental health that allows them to fulfill their professional obligations, colleagues and hospital systems can and should play an important role.
- Those in need of help may be identified before patients or practitioners are put at risk.
- Prevention is preferable to treatment, particularly when dealing with substance abuse.
- Prevention is best achieved through restriction of access to drugs of abuse.

Case 2

- Better interinstitution information systems can help ease transmission of critical medical history.
- Practitioners must make a priority of staying current with the latest techniques, guidelines, and recommendations.
- Simulation training offers a way to develop procedural skills, team communication, and emergency preparedness in a safe environment.

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