Chapter

48 QUALITY AND PATIENT SAFETY IN ANESTHESIA CARE

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Clinical anesthesia practice is often labeled as a model for quality and safety in medicine. In 1999, the Institute of Medicine (now the Health and Medicine Division of the National Academies) report, "To Err Is Human: Building a Safer Health System," specifically identified anesthesia as "an area in which very impressive improvements in safety have been made." Such attention to a specialty comprising approximately 5% of U.S. physicians highlights the many contributions to overall perioperative quality and safety generated by the specialty of anesthesia. Although actual reductions in anesthesia-specific mortality rates are controversial,[1] ailing patients are anesthetized for more invasive operations than a few decades ago. The principles by which anesthesiologists transformed the inherently dangerous task of reversibly blunting human responses to pain and physical damage and controlling vital life-support functions into a safe and almost routine occurrence should be familiar to all practicing anesthesia providers.

This chapter reviews the history of anesthesia quality and safety, identifies key approaches and strategies that have contributed not only to anesthesia but to other medical specialties, and examines current and future challenges in anesthesia-related quality and safety.

DEFINITIONS: QUALITY VERSUS SAFETY

Quality and safety are related terms but are not identical. Safety refers to a lack of harm and focuses on avoiding adverse events. If patient injury is avoided, then the process is safe. In contrast, quality refers to the optimal performance of a task, which may refer to outcome,

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efficiency, cost, satisfaction, or some other metric of performance in addition to avoiding injury.

It is easy to see how quality and safety do not always overlap. As an example, a process can in principle always be made somewhat safer by installing an additional check or adding extra equipment. Taken to its extreme, it can be argued that an anesthesia provider is not fully safe unless a fiberoptic scope is in the operating room for induction of anesthesia. Another example is concluding that safety could be improved by having a second (or third) anesthesia provider in the room as well! Clearly, such an approach could incrementally create more safety but would not necessarily produce more quality. In contrast, quality includes an "optimization" element, so if a process is changed to produce better patient satisfaction, for example, or a shorter length of stay, it represents higher quality but not necessarily better safety.

In the anesthesia realm, the use of ultrasound to place central lines is an example of a strategy that improves both quality and safety. By reducing the incidence of carotid puncture,[2] ultrasound clearly improves safety. By reducing the time to successful insertion (and the number of misses), ultrasound improves quality as well. In contrast, pin indexing backup oxygen tanks adds safety, but does not really change quality.

Historically, advances in anesthesia performance have addressed both quality and safety as described in this chapter.

SPECIFIC APPROACHES TO ANESTHESIA SAFETY

Learning From Experience

Because the mechanisms by which most anesthetics exert their effects are not fully understood, and because many intraoperative states (one-lung ventilation, muscle relaxation, cardiopulmonary bypass) are not found in normal human activity, a large component of anesthesia safety is derived from a history of empiric observation and experience. Driven by the goal of minimizing anesthesia-specific fatality and the shockingly high mortality rate during the early years of anesthesia practice,[3] anesthesiologists have over time systematically accumulated an experience base of observations about safety. Emery A. Rovenstine's case series of nine cardiac arrests, published in 1951,[4] is an example of this empiric approach. Although he offered no definitive solution, his practical observations (e.g., cardiac massage through the diaphragm is ineffective, the differential diagnosis of shock versus cardiac standstill can be difficult) allowed anesthesia providers to incrementally and empirically improve anesthesia safety.

Beecher and Todd's exhaustive 1954 study of anesthesia-associated deaths in 10 centers over 4 years stands as a prime example of the empiric approach to anesthesia safety.[3] Involving 21 physicians and 11 secretaries over 5 years, Beecher tracked the outcomes of 599,548 anesthetics, identified 7977 deaths (more than 1 in 100) and cataloged the causes as from patient disease, surgical error, or anesthesia. Their observation that patients who had received neuromuscular blocking drugs had a significantly higher perioperative morbidity rate is still a subject for anesthesia trainees today.

Other examples of empirically derived anesthesia safety observations include the surprising difficulty in detecting esophageal intubation (or arterial desaturation), the tendency of some anesthetics (e.g., desflurane) to trigger hypertensive tachycardic responses,[5] the dangers of circuit disconnection, and the potential for delivery of a hypoxic gas mixture. In all, the anesthesia approach has been to identify and describe such events, determine how they might occur in clinical practice, develop and test countermeasures, and disseminate the results through technical improvements or education. Although most of these anesthesia-related adverse events are by now rare in occurrence, they highlight a key approach: recognize a potentially preventable event, evaluate its likelihood, and systematically develop countermeasures to reduce the incidence. Taken together, observations such as these have led to reductions in anesthesia-related mortality rates, with current estimates ranging from 1:250,000 for healthy patients[6] to 1:1500 for those with complex medical problems.[1]

In addition to empiric observations about patient-related safety, anesthesiologists have addressed safety issues related to provider performance. An everyday example is in the interface between the anesthesia provider and anesthesia delivery system (also see Chapter 15). As in aviation, the human–anesthesia machine interface has been designed specifically to reduce inadvertent errors. In the same way that levers in an airplane for landing gear and flap control have a knob shaped like a wheel and a flap, for example, so is the knob on an anesthesia machine for oxygen gas flow shaped differently from knobs controlling air and nitrous oxide, and it is always located on the right. Similarly, the potentially dangerous delivery of hypoxic gas mixtures is prevented by "linking" the oxygen flow to the nitrous oxide flow so that oxygen is always present in fresh gas flow. Nonuniversal connectors to ensure that oxygen is being delivered through the oxygen flowmeter, and an oxygen analyzer to serve as a final check on the delivered gas mixture are other examples of safety mechanisms designed to avoid the inadvertent delivery of a hypoxic gas mixture.

Even though adverse events due to failure of mechanical ventilation or hypoxic gas delivery have almost been eradicated in anesthesia, this process of empiric observation continues today. Recent awareness of the dangers of anemia during spine surgery (also see Chapter 32),[7] hypotension in the sitting position (also see Chapter 19),[8]

or the role of fibrinogen in coagulopathy during maternal hemorrhage (also see Chapter 33)[9] are current examples of issues identified through empiric observation.

Adoption of Specialty-Wide Standards

Because anesthesia is normally administered in conjunction with therapeutic or diagnostic procedures, identifying adverse outcomes attributable specifically to the anesthesia practice is challenging. In fact, one of Beecher and Todd's explicit goals in their landmark study was to define "the extent of the responsibility which must be borne by anesthesia for failure in the care of the surgical patient."[3] Because adverse events clearly attributed to anesthesia are rare, promulgating appropriate countermeasures across the specialty is difficult. Nevertheless, anesthesia was the first medical specialty to embrace universally applicable standards, developing and promulgating a set of monitoring recommendations with the goal of reducing anesthesia-related adverse events. Driven in part by high malpractice awards, these standards included continuous anesthesiologist presence and vital sign monitoring including blood pressure, heart rate, electrocardiogram, breathing system oxygen concentration, and temperature and were initially published as a research article from a single health care consortium[10] and developed from a database of adverse events.

Although not evidence-based, these standards were incorporated as intraoperative monitoring standards by the American Society of Anesthesiologists (ASA) 2 months later and have remained as one of only three practice standards endorsed by the ASA (the other two being standards for pre- and postoperative care).[11] Since their adoption, conclusive evidence for the efficacy of these standards has remained elusive, but retrospective observations have suggested benefit. In a follow-up study, the authors of the monitoring standards published a case series of 11 major intraoperative accidents attributable to anesthesia from 1976 to 1988, but found that only one occurred after universal adoption of the monitoring standards.[12] Observations from the ASA Closed Claims Project database also suggest a reduction in the number of claims for death or permanent brain damage during that period.[13]

Whether monitoring standards or (possibly) new technologies were responsible for a perceived reduction in adverse events, the willingness of anesthesia providers as a group to adopt practice standards remains an approach almost unique to anesthesiologists and a marker for the priority anesthesiologists put on safety.

Patient Safety–Focused Programs

A third element characteristic of the anesthesia approach to patient safety is the formation of patient safety–focused specialty entities. Existing only for the promulgation of safety, these societies represent an important aspect of the anesthesia approach to patient safety.

Foremost among these groups is the Anesthesia Patient Safety Foundation (APSF), an independent nonprofit corporation begun in 1985 with the vision "that no patient shall be harmed by anesthesia." Supported by the ASA and corporate sponsors, APSF members include anesthesiologists, nurse anesthetists, manufacturers of equipment and drugs, engineers, and insurers.

The clinical impact of the APSF has been immense. The APSF newsletter, published four times a year,[14] has become one of the most widely circulated anesthesia publications in the world and is dedicated solely to safety. Identifying aspects of anesthesia practice with significant potential for adverse consequences, the APSF newsletter has highlighted diverse issues such as the anesthesia machine checkout, opioid-induced respiratory depression, residual neuromuscular blockade, postoperative visual loss, and emergency manual use. Instructional videos, research grants, and other special conferences are also part of the APSF effort to promote safety.

A second entity with a unique approach to safety is the ASA Closed Claims Project.[13] Operating in cooperation with malpractice lawyers, the Closed Claims Project group reviews data from settled anesthesia lawsuits to identify anesthesia safety concerns that may be amenable to targeted efforts. In a series of academic publications since 1988 and continuing into the present, the Closed Claims Project has investigated a wide range of topics (Table 48.1) focusing on rare events difficult to study systematically. Although such analyses cannot estimate incidences or risk factors, they provide a wealth of descriptive information that has helped anesthesiologists address patient safety issues. Among these are the recognition that listening to the chest may not be a reliable method of detecting esophageal intubation[13] and that a common factor in adverse outcomes due to massive hemorrhage is late recognition.[16]

The Anesthesia Quality Institute (AQI) is the newest and potentially largest patient safety project sponsored by organized anesthesia.[21] Begun in 2008, the goal of the AQI was to "to be the primary source of information for quality improvement in the clinical practice of anesthesiology." Sponsored by the ASA, the AQI administers and supports an Anesthesia Incident Reporting System (AIRS) and the National Anesthesia Clinical Outcomes Registry (NACOR), which currently captures information on approximately 25% of all the anesthetics administered in the United States. The goal is to capture enough anesthetic data that accurate benchmarking of clinical outcomes related to anesthesia can be performed and informed efforts to improve quality can occur.

Table 48.1 Noteworthy Closed Claims Project Observations

Year	Title	No. of Claims	Notable Finding(s)
1988	Cardiac arrest during spinal anesthesia[17]	14	Bradycardia was the most common presenting symptom with hypotension as the second. Epinephrine was not given until 8 minutes (mean) after onset of asystole.
1990	Adverse respiratory events in anesthesia[15]	522	Death/brain damage occurred in 85% of cases. In 48% of esophageal intubations, auscultation of breath sounds was performed and documented.
1999	Nerve injury associated with anesthesia[18]	670	Ulnar nerve injuries were most frequent, were associated with general anesthesia, and occurred predominantly in men.
2006	Injury associated with monitored anesthesia care[19]	121	Monitored anesthesia care claims involved older and sicker patients than general anesthesia claims. Respiratory depression due to sedative/opioid administration was the most common mechanism of damage (21%). The combination of electrocautery and oxygen was a recognized mechanism in 17%.
2014	Massive hemorrhage[16]	3211	30% of claims involved obstetrics, and thoracic/lumbar spine procedures were also overrepresented. Recognition and initiation of transfusion therapy were commonly delayed.
2015	Postoperative opioid-induced respiratory depression[20]	357	88% of events occurred within 24 hours of surgery, and somnolence was noted in 62% before the event.

FROM SAFETY TO QUALITY: MAKING ANESTHESIA BOTH SAFER AND BETTER

Although most observers believe anesthesia care to be safer today than 50 years ago, whether the quality of anesthesia care has improved is less clear. Incorporating not only safety but efficiency, cost, and patient comfort and satisfaction, anesthesia quality has many more dimensions than the avoidance of adverse outcomes.

Several barriers exist to measuring and improving anesthesia quality. Because the relative contribution of anesthesia to the outcome of surgical procedures is difficult to define, identifying how anesthetic care might have made a difference is likewise challenging. It is easy to see that if a patient goes home a day sooner after a colectomy, for example, determining whether that improvement is due to anesthesia, surgery, or hospital care is extremely difficult. More than likely, this type of improvement is a result of all variables.

Process Measures

The most significant obstacle to anesthesia quality is knowledge of patient outcomes. Because most of the patient's pre- and postoperative course lies outside the preoperative clinic, operating room, and postanesthesia care unit, understanding how a patient's clinical course is affected by alterations in anesthesia care requires considerable effort to follow patients into the postoperative phase. For this reason, early attempts to improve anesthesia quality focused on perioperative processes rather than outcomes. The Surgical Care Improvement Project, or SCIP, was a national test of this approach. By incentivizing the public reporting of hospital performance on evidence-based process measures such as administering antibiotics in a timely fashion and verifying the continuation of preoperative β-adrenergic blockers into the perioperative period, policymakers hoped to improve quality by improving perioperative processes of care. Puzzlingly, however, over the 8-year history of the SCIP project (2006-2014), performance on nearly all process measures included in the project improved, but outcomes (whether surgical site infections[22,23] or mortality rate[24]) failed to improve. In fact, because of concern regarding adverse outcomes from potentially harmful process measures,[25] several related process measures were also rescinded. Among these were whether β-adrenergic blockers were given to patients within 24 hours of an admission for myocardial infarction[26] and verifying that antibiotics were given within 4 hours of an emergency room visit for pneumonia.[27]

Why implementation of a suite of process measures, all with literature support, have not clearly improved patient outcomes remains a mystery. Clearly, improving quality by mandating specific processes of care is not

straightforward and has led quality experts to be much more reluctant to embrace process measures alone as a method of assessing care quality.

Structural Measures

Measuring structural elements can also provide a glimpse into the presence or absence of quality. Structure refers to the presence or absence of specific organizational features that are considered to be integral to the provision of high-quality care. If present, such features then suggest that the clinical care is of high quality.

Examples of structural elements considered to correlate with quality care include the ready availability of diagnostic radiologic testing, having physicians on call for emergencies, an electronic medical record, and mandating a dedicated intensivist for all critical care units. The presence of an active quality improvement mechanism might also be considered a structural feature of high-quality care. Although structural quality is relatively invisible to trainees unfamiliar with diversity in health care environments, hospital rules governing nurse-patient ratios, timely availability of obstetric anesthesia specialists, and a protocol for hand hygiene are examples.

Although structural measures are generally easy to measure, the link between structure and improved outcomes is often difficult to discern. The availability of in-house critical care attending physicians at night, for example, is intuitively reasonable, and would be a relatively easy structural feature to measure. However, more than one study[28,29] suggests that hospitals that have implemented an in-house night-call system might not see clear improvements in outcomes.

Outcome Measures

One logical consequence of an inability to identify clinically relevant process measures is to focus instead on outcome. Because there is considerable practice variability in anesthesia,[30,31] variability in outcomes likely exists. In principle, by identifying "bright spot" institutions that have better outcomes, the corresponding best practices can be identified and disseminated. Although NACOR is not yet mature enough to allow outcome analysis, surgical databases are approaching that goal. The Society of Thoracic Surgeons (STS) Adult Cardiac Surgery Database is perhaps the best example, capturing data from more than 90% of all cardiac procedures in the United States.[32] Other databases include the National Surgical Quality Improvement Program (NSQIP) and National Inpatient Sample (NIS). Because sufficiently complete data for outcome reporting has historically not been available, few hospitals have routinely made outcome data available to their clinical care staff. In addition, outcome reporting for anesthesiologists in particular is challenging because events that occur postoperatively may not be related to anesthesia care per se. Such an approach is changing, however, as hospitals recognize the value of feedback. Monthly central line and catheter-related urinary tract infection rates posted in the intensive care unit or patient satisfaction scores posted in the operating room are examples.

Outcome reporting initially seems straightforward and gives individuals or institutions a benchmark for measuring future performance. But accurately comparing outcomes between individuals or institutions requires some way to adjust for patient conditions unrelated to the anesthesia or surgical (or hospital) care. This "risk adjustment" can be extremely difficult as different adjustment algorithms may produce different results,[33] algorithms may be vulnerable to "gaming" by inducing favorable patient selection,[34] the accuracy of data may be suspect,[35] and the adjustment algorithm itself may not be consistent from year to year.[36]

Current evidence is mixed with regard to whether outcome reporting improves outcomes. Two 2015 studies[37,38] suggest that knowing one's outcomes may not by itself drive improvement. In addition, should a "bright spot" institution with unusually good outcomes be recognized, identifying and disseminating lessons from that institution would likely involve developing a set of process measures, which (as the SCIP program demonstrates) may not have the desired effect.

Nevertheless, the use of both process and outcome measures are key to quality improvement. As the management consultant Peter Drucker once noted, "You can't manage what you can't measure." Yet measurement alone is inadequate. Our current experience with both process and outcome measurement is that neither readily leads to improved quality. Further work is needed to better understand how to use outcome and process measurements to drive quality.

TOOLS FOR IMPROVING LOCAL OUTCOMES

In addition to empiric observation, improving quality and safety occurs continuously at the local level and is driven by individuals, departments, or hospitals. This section discusses tools in widespread use for quality improvement.

Structured Quality Improvement Programs: FADE, PDSA, and DMAIC

Because clinical care can be extremely complex and multifaceted, knowing where or how to begin a quality improvement project can be difficult. The acronyms FADE, PDSA, and DMAIC refer to commonly used blueprints for initiating and executing a quality improvement project. Although the letters are different, all three apply the same basic model: evaluate, implement, measure.

FADE stands for Focus/Analyze/Develop/Execute-evaluate. As the words suggest, one should first focus on the process to be improved, analyze data to establish root

cases and baseline performance, use the data to develop an action plan, then execute the plan and evaluate the result. PDSA stands for Plan/Do/Study/Act. As one might imagine, the general gist of a PDSA is similar to FADE. DMAIC stands for Define/Measure/Analyze/Improve/Control, which follows essentially the same process.

Because identifying, intervening, and assessing the outcome are core aspects of the anesthesia skill set, anesthesiologists are likely familiar with the general structure of a FADE or PDSA quality improvement program. After all, the simple act of titrating an anesthetic requires that a situational assessment be made, the anesthetic level be adjusted, and the outcome reviewed. However, creating lasting change is more difficult than it appears. A common trap in developing a quality improvement program is to identify an imperfect step and apply a remedy to that specific step without understanding or addressing how that step came to be imperfect. A plan to improve delivery of blood products to the operating room, for example, may be ineffective if the process for ordering blood is not also addressed (also see Chapter 24). Another often missed aspect of quality improvement is the implementation of a change without measuring the result of that change. If an intraoperative handoff tool is implemented, for example, but no improvement in handoff errors results, one possibility is that compliance with the tool is poor. Attention to such details will help optimize the results of any quality improvement project.

Multidisciplinary Process Improvement: Root Cause Analysis, "Never Events," and Failure Mode Effects Analysis

Root cause analysis (RCA) was developed by manufacturers in the 1950s to better understand industrial events. The goal is, as the title suggests, to identify the primary, or "root," cause of the problem under analysis. One of the first users of this technique was Toyota, who famously used the "5 whys" technique. By asking "why" at least five times during the investigation of a breakdown or undesired event, quality personnel are forced to drill down layer by layer to understand progressively more fundamental causes.

When applied in medicine, the root cause process begins with a multidisciplinary group assembled to evaluate every step of the process that resulted in the event in question. Attention is focused strictly on system processes and not on individual provider behavior. A causal factor chart is often created in skeleton form, with details added as each specialty adds their expertise. Fig. 48.1 depicts a sample factor chart for an intraoperative transfusion reaction[39] (also see Chapter 24).

Although such charts are usually read from left to right, they are often created from right to left, starting with the event and using logic and time information to add relevant causal factors. Note also that the blood bank, hospital engineering, preoperative nursing, anesthesia, and surgery

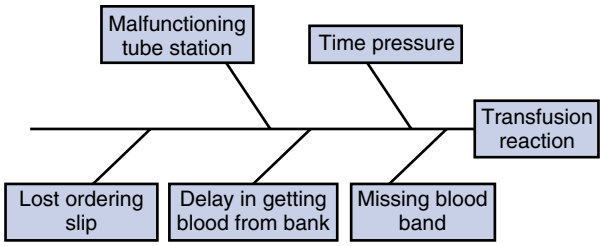

Fig. 48.1 Sample causal factor chart. (From Tung A. Sentinel events and how to learn from them. *Int Anesthesiol Clin.* 2014;52:53-68.)

Box 48.1 Sentinel Events Related to the Perioperative Period as Defined by The Joint Commission, 2015

- Hemolytic transfusion reaction (also see Chapter 24)
- Invasive procedure on the wrong patient, wrong site, or wrong procedure
- Prolonged fluoroscopy > 1500 rads
- Fire, flame, or unanticipated smoke, heat, or flashes during an episode of patient care
- Any intrapartum maternal death or severe morbidity

Rads, Radiation absorbed dose units.

are all involved in this particular event, underscoring the multidisciplinary nature of properly performed RCAs.

An RCA is mandated by The Joint Commission, a United States–based nonprofit organization that accredits health care organizations and programs, whenever an accredited hospital experiences one of several prespecified types of adverse events. Such events are called "sentinel" because they expose a dangerous "gap" in care and signal the need for immediate investigation and response. A list of all The Joint Commission–designated events can be accessed at their website.[40] Sentinel events relevant to the perioperative period are listed in Box 48.1.

The Joint Commission also explicitly defines events that do *not* require focused reporting and review. These include any near miss, medication errors that do *not* result in death or functional loss, minor hemolysis, or death or functional loss after leaving against medical advice.

The Joint Commission requires (as a condition of accreditation) that hospitals respond to such events within 45 days by reporting them to The Joint Commission, performing an RCA, and developing an action plan to identify strategies the hospital intends to implement to reduce the risk of similar events in the future. Such a plan must include the action to be taken, who will implement, a time line for implementation, and strategies for measuring the result and sustaining the changes. Although reporting to The Joint Commission is voluntary, identification of such events is a key component of accreditation visits.

Other patient safety organizations have suggested modifications to The Joint Commission list. The National Quality Forum (NQF), for example, endorses a large list

of "serious reportable events" that should never occur. Besides The Joint Commission list, the NQF adds "intraoperative death in an ASA class I patient," death/disability from the irretrievable loss of an irreplaceable biologic specimen, and death from electric shock.

Although intuitively reasonable, the real world effectiveness of an RCA can be variable.[41] Adverse events and their investigation are often emotionally charged, and meetings to determine cause can be limited by blame-oriented analysis (which leads to relatively weak "blame and train" remedies). Studies of action plans and implementations suggest that relatively few of these actively target true "root" causes.[42] An inadequate RCA may result from lack of time, inadequate resources, and even disagreement among reviewers with respect to "root" causes.[43] Even when appropriate action plans are created, insufficient resources may prevent effective implementation.

One highly useful outcome of The Joint Commission Sentinel Event program is their series of sentinel event alerts.[44] By maintaining a database of reported events, The Joint Commission can identify trends in safety events and issue bulletins to warn clinicians of potential issues. To date, this program has resulted in more than 50 events including several relevant to anesthesia such as deaths due to concentrated potassium chloride solutions, ventilator-related deaths, medical gas mix-ups, transfusion errors, disruptive behavior, and magnetic resonance imaging accidents. Reports include case descriptions and analysis including the Manufacturer and User Facility Device Experience (MAUDE) database.[45]

One of the major drawbacks to the RCA process is its retrospective nature. Process flaws in care delivery may not be addressed until the event actually occurs and a patient is harmed. To address this problem, the Failure Mode Effects Analysis (FMEA) has been adopted from industry to prospectively identify high-risk aspects of clinical care.

An FMEA is a resource-intensive, comprehensive analysis of a specific process, with the goal of identifying all the potential ways that it can fail. A process to identify and record patient allergies, for example, might fail if the interviewer is unable to accurately identify allergies, if the documentation form is difficult to read or inaccessible, or if medications sound alike. In addition to simulation and imagination, a team should use other sources to identify potential failures including sentinel event alerts, Institute for Safe Medication Practices information, and Food and Drug Administration databases and advisories.

It is easy to see that an FMEA analysis of even a straightforward process is extremely time consuming. Even if most of the relevant failure modes can be identified, implementing effective change can be difficult, in part because no bad event has yet occurred. As a result, FMEA analyses should be reserved for large-volume, high-risk processes for which the risk of catastrophic failure is clear.

SUMMARY

Anesthesia providers should routinely strive for the highest quality care they can deliver. Because procedures and anesthetic strategies routinely evolve to meet changing needs, quality and safety in anesthesia present by definition a moving target.

Historically, anesthesiologists have led in patient safety by being willing to embrace several practical approaches. Among these are the empiric cataloging of events, a recognition of human-machine interface errors as a significant contributor to adverse events, adoption of strategies from other highly technical fields, and early specialty-wide agreement with respect to practice standards.

Organized patient safety–focused organizations within the specialty have also contributed considerably to anesthesia safety with innovative approaches. These groups include the APSF and the ASA Closed Claims Project.

In part because knowledge regarding care outcomes has been lacking, anesthesiologists have only recently begun to focus in the same way on care quality. The availability not only of specialty registries, such as the STS Adult Cardiac Surgery Database, but of large surgical databases such as NACOR and NSQIP has allowed anesthesiologists to move beyond process and structural measures and toward outcome measurement. Although no "magic bullet" strategy to quality improvement has yet emerged, process, structure, and outcome are all key elements in any comprehensive quality program.

Finally, multiple tools exist at the departmental and institutional level for quality improvement. These tools include blueprints for local quality projects, nationally promulgated sentinel event programs, and root cause and failure mode analyses for adverse events.

Taken together, numerous quality and safety tools and approaches are available to anesthesia teams interested in patient safety. With the growth and maturation of large perioperative databases, and the potential of electronic intraoperative records to shed light into the perioperative period, even more options will become available to make anesthesia practice safer and increased quality in upcoming years.

QUESTIONS OF THE DAY

1. What is the difference between quality and safety in anesthesia care?
2. What is the rationale for using process measures, structural measures, or outcome measures as a means to improve quality?
3. How can the PDSA (Plan/Do/Study/Act) process be used as a framework for a local quality improvement initiative?
4. What are the key steps in performing an root cause analysis (RCA)? What are the potential benefits and drawbacks to the RCA process?

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