Evolving insights for preventing surgeon errors: Balancing professionalism and cognition with knowledge and skill

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Errors that lead to adverse events occur in 2.9 percent to 3.7 percent of hospital admissions, and more than half of the adverse events that occur in surgical patients involve errors.[1-3] The Institute of Medicine—now the National Academy of Medicine (NAM)—began its study of adverse events as the data accrued and discovered the surprising prevalence of errors. The NAM published its first report, *To Err Is Human: Building a Safer Health System,* in 1999.[4] Initially, surgeons were skeptical of the findings in the report but gradually embraced the reality that errors were a critical factor in complications and poor outcomes. This realization led the American College of Surgeons (ACS) and the surgical community as a whole to begin studying surgical errors and to identify ways to broaden and improve the focus of surgical education.

As a first step in examining adverse events, the ACS and other stakeholders began investigating the causes of surgical errors. Because errors rarely were reported, the only source of information was closed liability claims. Surgeons had always assumed that surgical errors were largely the result of insufficient technical skill or medical knowledge; however, data from closed claims against surgeons indicated that there were other critically important factors involved.[5-8] This revelation has empowered the surgical community to develop strategies to enhance error prevention and to improve outcomes.

In the process of seeking the causes of surgical errors, some of the preventive measures employed to prevent them were obvious and had been previously reported.[5-8] Since then, more complex insights have evolved. The purpose of this review is to amalgamate information gained over time and to provide suggestions on how we can prevent errors based on what we have learned.

Technical errors

Technical errors are common. However, these errors are rarely the result of deficient technical skill. In a 1999 report, researchers at the Harvard School of Public Health and at Harvard's Brigham and Women's Hospital, Boston, MA, collected data from closed claims that confirmed the importance of technical competence in the prevention of errors and that technical skill was a small part of technical competence.[3]

In 2007, the ACS Closed Claims Study reported data collected from closed claims and found that technical errors occurred in 229 of 460 liability claims.[5] However, the surgeon reviewers found technical skill clearly deficient in only 11 percent of these cases. All of these cases involved scope-of-practice issues. Admittedly, it was impossible to judge the surgeons' technical skills in 46 percent of cases involving technical errors. For these claims, the reviewers either did not have access to information regarding the frequency of technical failure in a given surgeon's experience with a specific procedure or could not clearly determine the degree to which confounding circumstances contributed to the error.

Determining the technical skill of a surgeon requires knowledge of the frequency of errors, not the presence of errors. Furthermore, technical skill only can be measured correctly when the circumstances—systematic factors—surrounding a physician's performance are taken into account. Our innate human limitations may lead to errors during the simplest procedures, and confounding circumstances, such as peritonitis, obesity, equipment failures, deficits in the institution's culture, dense adhesions, and anatomic enigmas, decrease the likelihood of positive outcomes.

Even so, errors caused by the failure to stay within our scope of practice are unacceptable. The ACS study revealed scope-of-practice problems in several areas:

- Failure to refer cases that require services outside of a surgeon's areas of expertise
- Failure to consult intraoperatively when a case unexpectedly deviates from a surgeon's area of expertise
- Failure to refer cases to a tertiary care facility when institutional ancillary care needs cannot be met within a surgeon's work environment
- Failure of attendings to provide proctoring for trainees or trainee failure to request attending supervision
- Failure of aging surgeons to scale back their scope of practice
- Failure of surgeons to properly introduce new technologies into practice due to inadequate training or proctoring

Surgeons should realize that staying within their scope of practice can minimize technical errors, reduce complications, and improve outcomes.

Errors and professional behavior

Behavioral traits such as diligence, tenacity, and vigilance affect patient care. The ACS Closed Claims Study identified behavioral violations in 78 percent of cases in which an error occurred, including inadequate communication with the patient and family and failure to pursue a postoperative problem (see Table 1).

Table 1. ACS Closed Claims Study: Behavioral failures

Types of behavioral failures	n	(Percentage)
Communicate with patient and/or family	157	(34)
Pursue an abnormal symptom or test result	117	(25)
Pursue a postoperative problem	115	(25)
Assess surgical problem before surgery	87	(19)
Enlist the support of proper consultant	5	(14)
See patient in a timely fashion	60	(13)
Cross coverage or continuity of care issues	54	(12)
Communicate with consultants	46	(10)
Stay within proper scope of practice	44	(10)
Assess comorbidities before surgery	26	(6)
Follow patient long enough postoperatively	29	(6)
Check test results	24	(5)
Maintain other	62	(14)

practice patterns		
At least one failed practice pattern	360	(78)
Total number of cases	460	(100)*

*Percentages sum to greater than 100 percent because reviewers could indicate more than one flaw per case.

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Reviewers were required to distinguish between behavioral diligence and behavioral skill. For example, some surgeons have excellent communication skills; others rely more on diligence. The Accreditation Council for Graduate Medical Education (ACGME) includes "interpersonal and communication skills" among six core competencies that physicians should master in training. Nonetheless, surgeon-reviewers found that lack of diligence and insufficient time, rather than lack of behavioral skill, resulted in most of these communications deficiencies. In other words, most of the surgeons possessed what behavioral scientists call "behavioral capability" but did not always exercise it.[9] One review of closed claims in New York State found communication barriers in 24 percent of the 178 cases.[10]

The relationship between behavior and knowledge is complex. The following behavioral aspects of patient care typically involve a degree of medical knowledge: failure to pursue an abnormal symptom or test result, failure to pursue a postoperative problem, failure to assess a surgical problem before surgery, and failure to assess comorbidities before surgery. Even so, the ACS Closed Claims Study found that, in most cases, while surgeons possessed the required knowledge, they failed to apply it.[6] If knowledge was lacking, the behavioral failure to stay within a proper scope of practice or the failure to enlist the support of a qualified consultant still placed the errors within the realm of behavioral deficiencies.

Behavioral failures led to a marked increase in the incidence of diagnosis-related errors, including failure to diagnose, delayed diagnosis, and failure to perform diagnostic tests (see Table 2).

Table 2. ACS Closed Claims Study: Damaging events with and without behavioral failures

	No violations in behavior		One or more violations in behavior		
Occurrence of damaging event	**n = 100**	**(Percentage)**	**n = 360**	**(Percentage)**	**p-value***
Any diagnostic error	31	(31)	219	(61)	0.00
Delay in diagnosis	16	(16)	109	(30)	0.01
Failure to diagnose	10	(10)	90	(25)	0.00
Failure to perform diagnostic tests	5	(5)	62	(17)	0.01
Misdiagnosis	2	(2)	11	(3)	0.57
Other diagnostic events	3	(3)	33	(9)	0.04
Any treatment error	93	(93)	341	(95)	0.51
Technical error during surgery	56	(56)	173	(48)	0.16
Delayed treatment	21	(21)	141	(39)	0.00
Failure to treat	6	(6)	55	(15)	0.02
Wrong treatment	3	(3)	40	(11)	0.02
Unnecessary surgery	1	(1)	15	(4)	0.13

Failure to stay within scope of practice	0	(0)	9	(3)	0.11
Other treatment events	21	(21)	68	(19)	0.64

*p-value is based on chi-square test.

†There were no significant differences between those with or without practice pattern violations by sex, wound class, functional health status, or known comorbidities.

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Behavioral deficiencies also caused frequent treatment errors. However, the incidence of errors in treatment was not statistically related to behavioral failures. This finding is to be expected since, unlike the treatment category, diagnostic errors do not include the element of technical skill. However, when data related to the preventability of complications and technical errors are compiled, the profound significance of behavior among these claims is revealed (see Table 3). Hence, when a technical error occurred in the presence of a behavioral violation, complications and their consequences were markedly escalated.

Table 3. ACS Closed Claims Study: Preventability of complication by occurrence of technical error and behavior violations, n (%)

Preventability of complication	Behavior violations occur n = 360	No behavior violations occur	Row total

		n = 100	
When technical error occurs*	n = 173	n = 56	n = 229
Preventable	134 (78)	25 (45)	159 (69)
Not preventable	6 (4)	19 (34)	25 (11)
Impossible to judge	33 (19)	12 (21)	45 (20)
When no technical error occurs†	n = 187	n = 44	n = 231
Preventable	76 (41)	0 (0)	76 (33)
Not preventable	28 (15)	34 (77)	62 (27)
Impossible to judge	83 (44)	10 (23)	93 (40)

*Chi-square = 42.635, df = 2 ($p < 0.000$).

†Chi-square = 73.540, df = 2 ($p < 0.000$).

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Because behavioral failures do not always lead to errors, surgeons sometimes fail to grasp their significance. Behavior is determined by its consequences. Surgeons continue to violate good behavioral practices in the care of patients because errors resulting from bad behavior occur infrequently enough that their significance is overlooked. In addition to surgeons' failure to recognize the consequences of negative professional behavior, surgeons are vulnerable to behavioral violations because we are overworked. Because reimbursement rates are low, surgeons often have a financial incentive to work longer or additional shifts.

Another factor contributing to the tendency of surgeons to overwork is the workforce shortage. Heavy caseloads may make it difficult to find time for attention to the behavioral elements of care. Combine this lack of opportunity for self-reflection with a failure to grasp the profound significance of our behavior, and errors are the inevitable result. We stop communicating. We examine images instead of patients, focusing all too often on incidental imaging or lab findings instead of patient complaints. We make decisions on the basis of numbers on a monitor reported to us by surrogates without the benefit of clinical correlation. We proceed without taking time for necessary forethought.

Good professional behavior enhances a surgeon's knowledge base and technical skill and helps him or her avoid errors and achieve the best possible outcomes. Especially when we are overworked and fatigued, we must slow down in order to accomplish ordinary tasks. Medical knowledge should be adequate if we work within a proper scope of practice, take the necessary time to seek and find additional information when needed, and consult as appropriate.

Errors and cognitive skills

In the Harvard medical practice study cited previously, mistakes in judgment were observed in 169 of the 258 claims that resulted from errors, but the investigators made no specific reference to cognition.[8] However, the surgeon reviewers who collected information for the ACS Closed Claims Study reported a complex relationship between medical knowledge, behavior, and cognition, although no specific data were collected.[6] Other researchers have estimated that 80 percent of misdiagnoses stem from cognitive errors.[4] Although difficult to measure, it is clear that cognitive errors are common and frequently have disastrous results.

Taking time to think is an aspect of diligent behavior; having the cognitive ability with which to think also is important. However, these qualities are not mutually exclusive; cognitive diligence and cognitive skill are both necessary to minimize errors.

In *How Doctors Think,* Jerome Groopman, MD, clarifies the complex interaction between thinking and knowledge.[11] The ability to recognize when we do not know something can be used to prompt skillful thinking. Realizing that what we know is based only on a modest level of understanding, we learn to thoughtfully challenge what we think we know when it is questioned or when facts and data do not fit that piece of knowledge. Clinical certainty on the part of a surgeon can sometimes stymie meaningful thinking when it is used defensively to hide uncertainty. Uncertainty can be helpful and lead to reflective cognition, which is a tool for dealing with the care of a patient that involves conflicting facts or data.

Dr. Groopman defines several types of cognitive mistakes that lead to medical errors. He illustrates these types of errors using real cases from his personal experience as a medical oncologist. For example, he defines an availability error as a cognitive mistake resulting in a faulty decision that is based on the ease with which a relevant example comes to mind.[11] For example, experienced surgeons may think the common bile duct is the cystic duct because it looks like the last 100 cystic ducts they have seen.

Lawrence Way, MD, FACS, has demonstrated the concept of illusions as causes of cognitive errors that lead to adverse technical events.[12] We suffer from the illusion that what we see is the cystic duct, causing us to injure the common bile duct and/or the common hepatic duct, all because we made an availability error—a cognitive mistake. We make these errors in haste, trying to save time, when, in fact, preventing the consequences of flawed cognition by thinking skillfully is a bigger and more effective time-saver. To think that what you see is possibly an illusion unless your dissection has established the critical view of safety requires no more than an instant.

Sometimes we make poor decisions based on affective errors in cognition. These errors result from a decision based on what we wish to be true. Surgeons often de-emphasize that which they fear. For example, a surgeon will choose to think that a postoperative patient's fever and distention are due to atelectasis and ileus, when in reality a leaking anastomosis or intra-abdominal abscess has not been ruled out. Delayed diagnosis and treatment of complications frequently stem from cognitive mistakes classified as affective errors. In these circumstances, a surgeon's medical knowledge is not applied sufficiently because of a cognitive error stemming from fear that proper evaluation will reveal a technical failure. Since this and other similar clinical patterns are often self-limiting, we do not easily learn that we must always think in terms of the worst clinical scenario to achieve the best outcomes.

Aggressive versus restrained behavior

If one thinks in terms of a bell-shaped curve, many surgeons in the middle portion of the curve can walk the line between care that is too aggressive and care that is too restrained. Others of us have personalities that tend toward one extreme or the other, which may lead to cognitive errors. Subconsciously, data and facts may be preferentially selected to confirm a plan of care in keeping with the surgeon's personality. These cognitive errors occur because of confirmatory bias and are preventable only if surgeons recognize these tendencies and consciously avoid this type of cognitive mistake. For example, overly aggressive, over-confident surgeons must recognize when plans for antrectomy should be abandoned in favor of pyloroplasty to prevent the risk of duodenal stump leak or bile duct injury in the face of a technically challenging penetrating duodenal ulcer. Overly reticent surgeons who fear failure must continue with pancreatoduodenectomy instead of choosing a bypass procedure that denies the patient a reasonable chance for cure.

Dr. Groopman also observed that some mistakes are caused by franchise errors, which are based on the idea that "whom you see is what you get."[11] If you see a surgeon for gastroesophageal reflux disease, you get a laparoscopic fundoplication; if you see an internist, you get medical management. This situation, which is associated with confirmatory bias, becomes fraught with medical errors. For example, a general surgeon seeing a patient with back pain and an umbilical hernia may preferentially select facts and data, repairing the hernia and ignoring the back pain. Two months later, the patient presents to the emergency department with a ruptured abdominal aortic aneurysm.

Search satisfaction errors occur when we fall prey to the natural tendency to stop searching and thinking after making a major finding. For example, a surgeon seeing a patient with left-sided abdominal pain finds a small left inguinal hernia. Additional history of rectal bleeding is missed. The hernia is skillfully repaired, the sutures are removed, and the patient is released. The pain and bleeding continue, the patient sees a different physician, and colonoscopy reveals sigmoid carcinoma.

A surgeon's biases toward a patient's culture, religion, socioeconomic status, or sexual orientation also may affect patient care. One study of physician-patient encounters queried data from 193 physicians with 618 patient encounters. The study found that physicians had more negative perceptions of African-American and low-income patients than of Caucasian and/or upper socioeconomic status patients.[13]

In summary, both diligently taking time to think and skillful thinking are required to prevent cognitive errors that often lead to preventable adverse events. Our tendency to attribute these errors in thinking to a lack of technical skill or medical knowledge thwarts our ability to learn from our cognitive mistakes.

Systems affect quality of care

Surgeons work at the point of service. The quality of the care we provide is only partly determined by our surgical knowledge, technical skill, professional behavior, and cognition. The other important determinants of quality are systems factors—elements of care that involve relationships between individuals, their tools, and the environment in which they work.[8] In the Harvard medical practice study, systems failure contributed to errors in 82 percent of the 258 claims involving patient injury.

In some cases, these systems closely aligned with the care we provide. The systems in which surgeons practice affect the quality of mechanical equipment, devices, and surgical instruments. They also affect institutional requirements for marking a surgical site and prompts for ordering prophylactic anticoagulants and antibiotics. Other systems factors are more difficult to associate with errors because they are remote to adverse events in time and place. These include decisions at the administrative level, such as a chief financial officer's decision for or against participation in the ACS National Surgical Quality Improvement Program (ACS NSQIP®), or at the medical staff level, such as the rules set forth by the credentials committee for safely introducing new technologies into surgical practice. Human factors also include a health care institution's policies regarding "as needed" nurses and nurse-to-patient ratios. Even the attitudes and knowledge of personnel at all levels are human factors among these systems that affect our ability to avoid errors at the point of service. Also included are patient-related factors such as the complexities of the primary surgical illnesses and comorbidities.

Peer review is a critical part of identifying the underlying cause of a negative outcome or near miss. These events are rarely the result of a single error. Even though a surgeon errs at the point of service, closed claims reviews and NAM reports have shown that the root cause of many surgical errors is systems failure.[1] One group found that 69 percent of errors are caused at least in part by systematic breaches.[8] But it is not a trade-off; systems help us succeed, and surgeon performance is essential for the success of systems. For example, when surgeons fail to use an institutional protocol for deep vein thrombosis prophylaxis, the system fails. Surgeons must be held accountable as individuals to work within the system.[14] To enhance the reporting of errors, peer review systems are largely non-punitive, but this lack of penalization should not mitigate accountability for failing to participate in systems of care. Recall the ACGME's sixth core competency: Be aware of and respond to systems-based practice.

One strategy to improve systems of care may be to use checklists. A standard surgical checklist, the Surgical Patient Safety System (SURPASS), was implemented in six hospitals and showed a significant reduction in complication rates.[15] Reviewing cases performed without a checklist, another study of 294 claims identified 412 contributing factors and concluded that SURPASS likely would have prevented 29 percent of the errors identified.[16]

In addition to accepting individual responsibility for the care we provide, we must also be aware of, and participate in, systems of care. Systems of care are designed to protect us from error, not to shelter us from accountability.

Sample case study

The following sample case illustrates many of the causes of medical errors and the complex interactions that make it difficult to identify the true causes of surgeon failures.

An otherwise healthy adult patient presented to the emergency department

(ED) with left lower quadrant pain, which had gradually increased over a two-day period, and mild nausea. The patient's temperature was 100 degrees, and the physical exam was negative except for lower abdominal rebound tenderness and guarding. Lab assessment was normal except for a white blood cell (WBC) count of 14,000 with a left shift. An abdominal and pelvic computed tomography scan revealed sigmoid diverticulitis. The patient was admitted, responded to antibiotics, and discharged five days later.

A month later, a colonoscopy revealed only diverticular disease. During the next six months, two more attacks occurred that were somewhat milder but that required outpatient antibiotics; a laparoscopic anterior resection was performed.

When the stapled anastomosis was checked intraoperatively with transrectal air, some air bubbles were noted. However, ongoing attempts to identify additional bubbles revealed none. It was decided to accept the anastomosis as intact without further exploration.

The patient did well initially. However, on the fourth postoperative day, the patient complained of mild lower abdominal pain. The patient's temperature was normal and tenderness was compatible with postoperative expectations. The WBC count was stable at 9,000. Because the surgeon was looking forward to beginning a long weekend off and the patient was eager to go home, a hasty generic handoff between the primary surgeon and call partner included plans for discharge on afternoon rounds.

That evening the call partner was busy and late for rounds. The patient wanted to go home. Finally, at the request of the patient, the surgeon was called. Happy to have one less patient to see, the call partner authorized discharge by verbal order.

The next evening, the patient presented in the ED with moderately severe generalized abdominal pain that had increased throughout the day. The abdomen was moderately tender with mild rebound in all quadrants but worse in the left lower quadrant. Blood pressure was 140/80, pulse was 96, and temperature was 99 degrees; the WBC count was 12,000. A transrectal Gastrografin study revealed extravasation of contrast into the left lower quadrant, and a computed tomography scan showed a large amount of free air throughout the abdomen. The patient was admitted and treated with antibiotics and intravenous fluids.

On rounds the next morning, the findings were unchanged, but later that evening, pain increased, blood pressure dropped to 90/60, and the pulse increased to 140. Oxygen saturation was 92 percent on room air. The surgeon was called, a fluid bolus and pressors were given, and the patient was taken to the operating room. A Hartmann's procedure was performed for a leaked anastomosis. In the operative note, the possibility that the circular stapling device may have misfired was mentioned.

Multi-organ system failure ensued. Three months later, after several more procedures for intra-abdominal abscesses, the patient was released from rehab with a granulating abdominal wound, loss of mental capacities, amputation of several digits, a healing tracheostomy site, and a colostomy.

This case involved a leaked anastomosis—a known, albeit infrequent, complication of anterior resection even in the hands of experienced, skillful surgeons. Having documented favorable prior experience with laparoscopy and the double-stapling technique, the primary surgeon's technical skills and scope of practice were validated.

Although brought into question, systems failure related to a failed stapling device was never proven. Systems-related problems beyond our control often are sought to explain failures and avoid personal responsibility.

An intraoperative cognitive error may have occurred: Was it a false hypothesis error to conclude that the air bubbles were trapped air, and should the procedure have been converted to open? In any case, the team was diligent, making ongoing efforts to demonstrate additional bubbles, which failed and led to an informed but possibly incorrect decision to complete the procedure laparoscopically. Failing to think is unacceptable; failing to think accurately is human.

The clearly preventable errors that followed were caused by behavioral and cognitive deficiencies. Diligent professional behavior required that the call partner see the patient prior to discharge. This behavioral deficiency may not have occurred if the handoff had been more comprehensive. Regardless of the quality of the handoff, and even if the findings at the bedside led to discharge, diligent behavior required a clinical assessment. This exemplifies how so often more than one part of a system has to fail before an error leading to injury occurs. It also emphasizes the surgeon's critical place within systems of care.

The on-call surgeon made additional behavioral errors in the ED, including failure to pursue an abnormal test and failure to cross-cover and provide continuity of care. These breakdowns may have been caused by fatigue while taking weekend call. Alternatively, and more incriminating, the behavior may have resulted from the fact that the patient did not "belong" to the call partner.

Human factors like fatigue, attitude, and competing priorities can affect cognition and behavior. The surgeon cherry-picked the available data, favoring the patient's relatively mild subjective clinical presentation—99 degree temperature, moderate pain and tenderness, satisfactory blood pressure and pulse, minimal elevation of the WBC count—over the objective findings of excessive free air and leaking contrast. The delay in treatment led to organ system failure and the dramatic escalation of the consequences of the anastomotic leak. As is so often the case, the technical error alone might have been effectively managed with acceptable temporary, albeit significant, consequences, but adding behavioral violations and cognitive mistakes stemming from lack of diligence as second, third, and fourth errors created an unacceptable perfect storm.

Conclusion

Surgeons are subject to fatigue, distractions, time constraints, competing priorities, workload, burnout, and other factors that occasionally affect our professional behavior and cognition. Certainly, other variables over which we have little or no control can adversely affect our success at the point of service. Nonetheless, deficiencies in professional behavior and cognition are frequent, avoidable causes of errors.

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