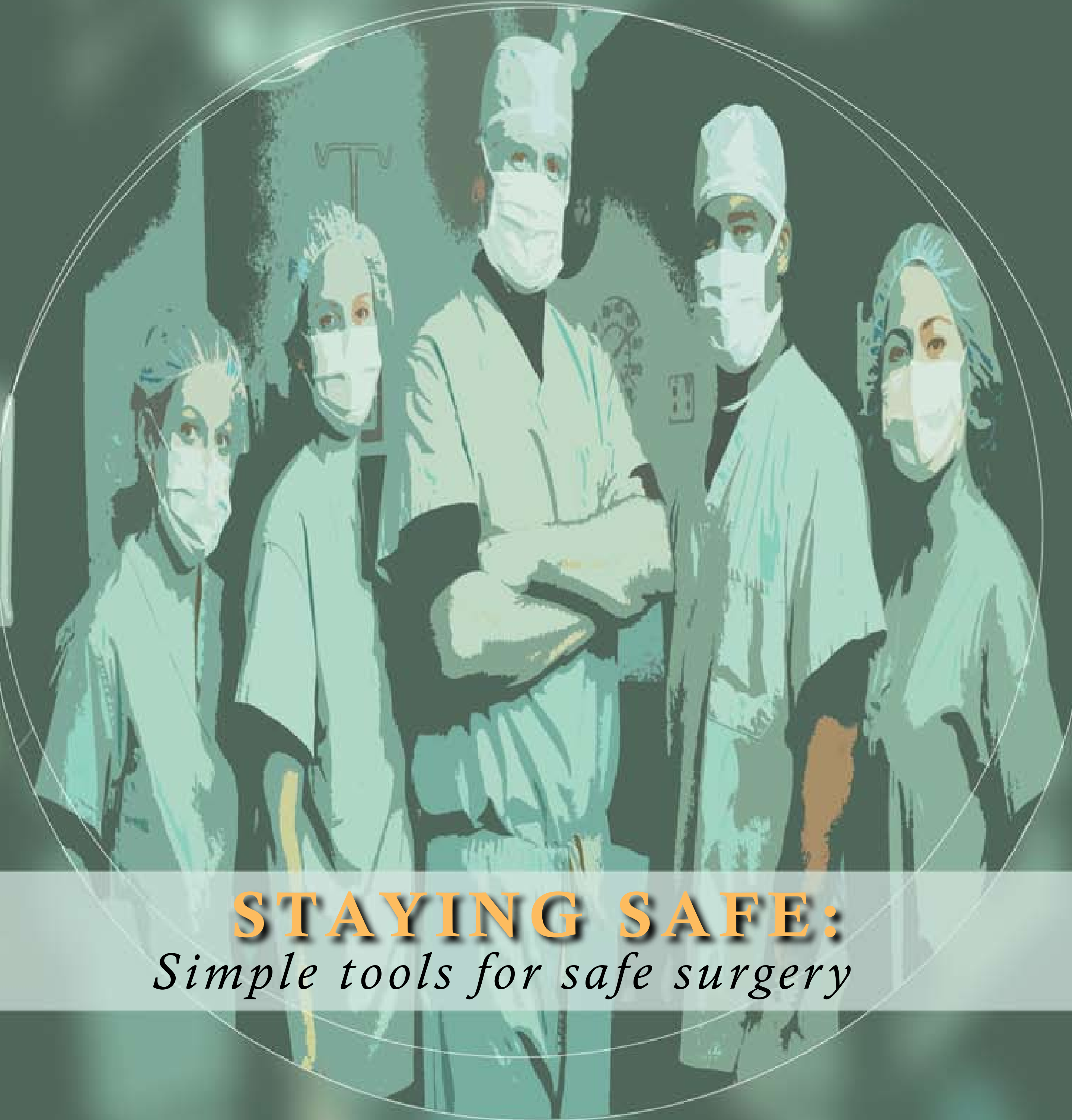

STAYING SAFE: Simple tools for safe surgery

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My operating team was closing the third case of the day and the sponge count wouldn't come out right. We had searched the drapes and the large, red, biological waste disposal bags. There was a delay getting the X-ray technician into the room. I was frustrated, and so was everybody else. I sensed we would all agree that there must be a better way. Two thoughts came into mind, almost colliding: It never seems this disorganized when I fly airplanes, and this extra anesthesia time was not good for this patient.

My own lifelong interest in surgery and in flying has led to some rather obvious comparisons between the two. Others, too, have started to draw the similarities. There is now a growing awareness in medicine that hospitals can be dangerous places and that medical error can contribute to death and harm. Many point to the expected, almost routine, safety of commercial flying as way to look for cues that may be useful in medicine. Is there a problem with medical error? How big is the problem? Will lessons learned in other dangerous industries like aviation, nuclear power, and the Navy submarine service be helpful in decreasing harm and death caused by medical error?

The problem and its size

In 1999, the Institute of Medicine (IOM) published *To Err Is Human.*[1] In this book, data were extrapolated from studies done in the early 1990s that indicated that as many as 100,000 lives a year are lost in U.S. hospitals because of medical error. Though most surgeons were aware of occasional events that were harmful to patients, the common conclusion among my colleagues at that time was that these events were occurring elsewhere, in some other hospital. After all, most U.S. doctors pride themselves on being highly trained professionals delivering high-quality, thoughtful care. But, as my own awareness grew, I began seeing and hearing about incidents that made me wonder if 100,000 lives a year was an underestimate. I'd hear about the liver resection patient who died on the table at one hospital, probably because of unappreciated blood loss by the surgeon, underresuscitation by the anesthesiologist, and poor communication between the two. I'd been told of the transhiatal esophagectomy with the unrecognized tracheal laceration at another institution and the young surgeon who was reluctant to ask for help. In discussion with friends around the country, I almost always was briefed on another horror story. I began to think that if we could cut the death rate from error in half, it would be the equivalent of curing breast cancer, which kills approximately 42,000 people a year.

Around the same time, I began to sense a number of less dramatic consequences of medical error. The patient didn't die but did end up with a wound infection, an avoidable colostomy, or a reoperation for a retained foreign body. Then, in December 2006, the Institute for Healthcare Improvement released data estimating that there are 15,000,000 incidents of harm "resulting from or contributed to by medical care."[2] When I saw this figure, I thought, what is going on here?

A lot is going on, it turns out. Though evidence for ways to practice safer surgery is accumulating, many surgeons are reluctant to adopt new ways of doing things. Papers detailing the consequences of mild hypothermia (threefold increase in surgical site infection rate, prolonged hospitalization) are well documented and published in our best journals,[3,4] but the thermostat in most operating rooms where I work is still set for my comfort and, until recently, my anesthesia colleagues and I rarely discussed the matter of temperature during an operation.

Tight glucose control has been shown in several studies to be associated with lower surgical site infection rates and, in critically ill patients, a 34 percent decrease in mortality.[5-7] Yet, glucose control is still managed with imprecise sliding scales for insulin administration in most hospitals.

Consider the gratuitous number of units of blood often administered in operating rooms where communication between the surgeon and the anesthesia team is limited or nonexistent.

Until recently, I'd be only vaguely aware of a transfusion during a case. I'd hear a nurse whispering the unit number and blood type to an anesthesia resident. Not uncommonly, it would turn out the patient had been hypotensive for a while and that pressors had been given. Though no blood had been lost, a transfusion had been ordered. Yet, it is now well documented that the immunosuppressive effects of a transfusion of packed cells more than triples the risk of nosocomial infection.[8,9] In cancer patients, blood transfusion has been linked to an increased recurrence rate in almost every primary site studied.[10,11] In the case I mention here, the cause of hypotension was a retractor pressing on the heart.

The possible solutions to the problem

Human factors studies have proven the adage of the IOM book: to err is human. In aviation, this assumption underlies the systems designed to detect potential errors, to "trap" them and, if they still occur, to correct them before harm occurs. In medicine, the surgeon is the "captain of the ship," and all responsibility rests on his or her shoulders. Our culture is more punitive than supportive, and likely most surgeons have witnessed the hostile behaviors associated with a surgeon's sense of insecurity. Many physician executives who participated in a survey reported encountering disruptive or dangerous physician behaviors on a regular basis.[12]

The airline captain used to be the captain of the ship too. But the investigation of multiple accidents attributed to pilot error revealed that often another member of the team in the cockpit was well aware of the danger but was not assertive enough to let it be known, and, ultimately, the crew was unable to avoid a fatal accident.[13] Gradually, aviation began to see pilots and flight engineers as crews, with the captain as the leader, though not the supreme being. In this model, sometimes called "crew resource management" (CRM), the leader seeks input from several sources but doesn't abdicate the ultimate responsibility for a safe flight.* I am reminded of the wisdom of this approach when I watch a young faculty member struggle with a laparoscopic cholecystectomy. Often the nurse standing next to the surgeon has seen a thousand such operations and has a clear idea as to what is the cystic duct and what isn't. Yet, the young surgeon does not ask her advice and she does not proffer it. In such cases, likely neither had been trained in CRM.

Checklists are also ubiquitous in aviation. Most serious aviators wouldn't consider a flight without strict adherence to the order and cadence of a well-written checklist. These are essentially reminders, not instructions, that require one pilot to respond to a challenge read by another. "Gear down?" will query the pilot. "Down with three green [lights]," comes the response from the other pilot. Such patterned responses are wonderful to listen to; they sound like the litany of a religious service.

Forcing functions are designed into airliners. Speed brakes—those slats on top of the wing—will not automatically deploy on landing until a certain tire speed is reached, assuring that the airplane is in fact on the ground. There are some forcing functions in medicine as well. Computerized physician order entry systems require the physician ordering a medicine to respond to questions about allergies and renal and hepatic function before the order will be fulfilled. These systems have resulted in a markedly decreased rate of harm from inappropriate orders.[14,15] Nonetheless, the use of checklists and forcing functions in medicine is primitive compared with other high-reliability systems. When it comes to checklist violations, imagine if you were the surgeon sewing in the heart-lung transplant in a young patient, only to hear that there is a blood type mismatch. Such a sinking feeling cannot be described.

When an emergency occurs in flight, pilots turn to emergency checklists and the Quick Reference Handbook (QRH), where carefully written algorithms guide anxious pilots to the safest course of action. Compare this approach with the common chaos in an operating room when an airway is lost or the patient's blood doesn't clot.

We have a long way to go in medicine, both substantively and culturally. Though the universal protocol was mandated in 2004, there were even more wrong site operations in 2005. In 2005, in Florida, there were 88 operations to remove a

*See related articles on the subject of error reduction and CRM by Gerald B. Healy, MD, FACS; Jack Barker, PhD; and Capt. Gregory Madonna in the February, June, and November 2006 issues of the *Bulletin*.

foreign body from a surgical procedure; 31 wrong site operations; and, in five instances, operations preformed on the wrong patient.[16] I sometimes think the term "timeout" is antithetical to the concept of safety woven into the fabric of what we do. It implies that safety is an exception, not a practice, and it is a term commonly used for disciplining errant children.

Almost every surgeon involved with a wrong site procedure reports doing a timeout and carefully marking the site. But marks get washed off and patients get repositioned and wrong site operations, as hard as they are to comprehend, do occur. Many states still hold the surgeon alone, rather than the entire team, responsible and punish them with fines and reprimands, as if they sought to do harm. We have yet to realize that these errors occur because of the systems we use in medicine, because people are fallible and because we have a culture of punishment or condescending disregard that inhibits many from speaking out about an impending mistake that may lead to harm or, worse, take a life.

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Types of error

It is helpful to see how errors occur so that systems can be designed to minimize their occurrence and catch those inevitable mistakes that do fall through the cracks.

Latent errors are those caused by the background of the workplace. Hospitals that allow fatigued surgeons to operate, cultures that prohibit a nurse from alerting a surgeon to an impending mistake, and organizations that don't address issues of maintenance are all breeding grounds for latent error.

Active errors are the type common to surgeons—for example, the common duct is severed or the portal vein is torn by rough hands. These errors can be attributed to knowledge, where the surgeon just doesn't know where the portal vein lies. Or the error can be related to experience, where the surgeon has studied the anatomy but has little actual experience developing that plane between the superior mesenteric vein and the neck of the pancreas. Finally, there are execution errors, where the surgeon knows and has experience, but for some reason—perhaps a distraction, lack of attentiveness, bravado, ennui, fatigue—the vein is still torn.

Planning errors are just that: the plan is bad. An example would be a recent case where a young surgeon divided the right branch of the bile duct and the right hepatic artery before recognizing what was obvious on the computed tomography scan: that the hepatic lesion was unresectable because of portal vein involvement.[17] The plan was poor because of lack of experience and lack of appropriate supervision.

When things go wrong

Most medical adverse events caused by error are the result of poor communication, checklist violations, loss of situational awareness, and latent error. Often caregivers aren't "on the same page," leading to miscommunication.

To address miscommunication in the submarine service, a simple way of transferring information, called "SBAR," has been developed. When telling another person about a situation, this patterned way of speaking—S=situation, B=background, A=assessment, and R=recommendation—is powerful. In medicine, rather than a phone call from hospital staff to a surgeon in the middle of the night with poorly organized data and no clear sense of expectation on the part of the person who has placed the call, a cogent, concise conversation can be constructed. As opposed to "Mrs. Smith doesn't look right," a call can be worded—using SBAR—like this: "Mrs. Smith has developed atrial fibrillation [S]. She had an uncomplicated esophagectomy two days ago [B]. Her heart rate is 160 and her systolic pressure is 100 [A]. I think we should move her to the unit and control her heart rate [R]."

The role of culture

The airplane cockpit and the operating room have a lot in common as well as some obvious differences. Airlines and hospitals have different cultures too. To expect that some CRM training alone will change the harm rate in medicine is an overly simplistic concept. Profound inherent differences, including the following, are obvious:

- In airline accidents, several people die at once, likely guaranteeing mention on the front page of the newspaper. Yet, 100,000 deaths a year in hospitals is the equivalent number of lives lost in four jumbo jet fatal crashes per week.
- Airline pilots work for the airline. If they deviate from the airline's training and standards, they are fired. Patients come to hospitals to be treated by surgeons, and as a result, surgeons exert considerable financial force on the institution's profit.
- Pilots are first at the scene of the crash. They are highly motivated to avoid an accident.
- Flights are cancelled when the airplane has a mechanical problem. Operations are undertaken precisely because there is a mechanical problem.

Additional differences are related to history and culture of these institutions, and some of these principles are ripe for adoption in medicine.

- Airline pilots are required to successfully pass recurrent simulator-based training and evaluation. Though surgery is moving toward a more robust assessment of competencies, these efforts are just beginning.
- Airline pilots have strict duty hour regulations, whereas surgeons do not.
- There is a "no fault" reporting system for aviation near-misses that is administered by the National Aeronautics and Space Administration (not the Federal Aviation Administration).
- New airline hires and new captains fly with check airmen during their initial operating experience. Newly appointed surgeons rarely operate with another surgeon experienced in hospital policy and culture.
- Below 10,000 feet, airlines maintain a "sterile cockpit," where no discussion is allowed unless it regards matters pertaining to the safe conduct of the flight.[†]
- Airlines constantly review safety with line-oriented safety audits. Observations are made of several flights and safety trends are observed. No interdiction with the crews occurs—the object is to review the process and not those particular pilots.
- Airlines learned long ago that there are certain weather conditions in which a safe landing is unlikely. Thus, an instrument approach cannot be initiated unless certain minimum conditions exist. Yet, a surgeon can operate on anybody he or she wants to, regardless of cardiac or pulmonary function or the likelihood that the operation will benefit the patient.
- Simulators are much more advanced in aviation than in medicine and in surgery.
- Pilots are hired after an exhaustive line-oriented interview, where interpersonal skills and collaborative abilities are assessed. Surgeons meeting a hospital's eligibility criteria are appointed and given operating room privileges without much consideration of emotional intelligence.

There is one more difference between these two systems: Without intending to diminish either glorious profession, as a pilot type-rated in the Boeing 737 and as a surgical oncologist, I can say unequivocally that surgery is much harder than flying.

Does any of this work?

All surgeons are data driven and we expect evidence to support the concept that aviation techniques can help reduce error. There is early evidence that these practices are effective. In a

[†]I am reminded of my own experience several years ago, when a fine surgical oncology fellow and I had just resected a large retroperitoneal tumor. In relief that we hadn't violated the inferior vena cava, we started talking about his children and, in a moment of inattention, injured the patient's ureter.

Kaiser Permanente hospital that instituted a briefing period before a procedure was performed, it was found that unexpected delays were cut in half and that nursing turnover, a major concern for hospital administrators and surgeons, decreased from 19 percent to zero. Furthermore, whereas three wrong site procedures had been reported before this briefing system was implemented, there was none afterwards.[18]

Dr. Karl in the cockpit.

What can you and I do?

There are several simple things we can do to reduce harm in our work. Start by recognizing that the people we work with are, almost without exception, bright, altruistic, and hardworking. They believe in the Hippocratic Oath, "Primum non nocere."

One way to increase safety is to put a white board in the operating room. On it, write the name of the patient, his or her age, and the medications that will affect the safe conduct of the operation. Include the site of the problem (for example, "left knee," or "esophageal adenocarcinoma at 35 cm"), and the names of everybody in the room. Use this simple tool as the centerpiece for a preoperative briefing. Make sure you, the nurses and technicians, and anesthesia staff have a shared view of the case. Discuss fluid administration, proposed length of the operation, and the possible difficulties. (I'll admit that when I started using a white board, my anesthesia colleagues looked at me as if I'd had a small stroke. They ultimately realized that this communication was helpful.)

Invite everyone in the room to speak up if they see something unusual or dangerous. This seems like an obvious thing to do, but saying these words out loud has a profound effect on the atmosphere in the room. I benefited recently when an alert technician reminded me that closing the chest without chest tubes was a deviation from our usual routine.

This preoperative briefing more than meets The Joint Commission's preoperative verification process requirements, and it sets a tone that is characterized by a relaxed, professional demeanor. Consider also operating without music. It is possible and it makes it easier to hear each other.

Require callouts from anesthesia every 30 minutes. This is a great chance to compare the progress of the surgeon to the progress of the patient. Blood pressure, pulse, urine output, temperature, and oxygenation can easily be discussed. It is a good time to let the anesthesia team know if you're having trouble or might run into bleeding.

Do a debrief at the end of the procedure. Review what might have been done differently. Share any special concerns with the post-anesthesia team. Communicate. Make a solid handoff of the patient. Be the leader. Support change to a safer environment.

Conclusion

Flying and operating are two of the most rewarding challenges in life. Both are exhilarating, sometimes frightening, always riveting. Both are more fun when things are organized to reduce surprises. I enjoy surgery more than ever, now that I've been using these simple tools. Ω

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