Minimizing Surgical Error by Incorporating Objective Assessment into Surgical Education

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Background

In 2000, the Institute of Medicine issued its landmark report, *To Err is Human,*[1] which revealed that as many as 98,000 in-hospital deaths result from medical errors each year,[2] and calculated a complication rate of 2.9% to 3.7%. The medical literature, however, reports rates three to four times the Institute of Medicine-reported rates. Healey and colleagues[3] report complication rates in the 11.0%[4] to 16.6%[5] range, and surgical adverse event rates span the 9% to 11%[3] and 7% to 16% ranges.[6] Surgical adverse events[7] accounted for two-thirds of all adverse events in Colorado and Utah, and a recent retrospective study by a fellow from the US Department of Health and Human Services Agency for Healthcare Research and Quality revealed that surgical adverse events were responsible for 12.5% of hospital deaths.[8] When randomly sampled settled surgical malpractice claims were reviewed, more than 50% were from technical error.[9] The literature concurs that as many as half of surgical adverse events are avoidable.[3-6,10-12]

Because surgeons regularly encounter adverse or unexpected conditions (eg, abnormal anatomy, friable tissue adhesions), optimization of technical approach to specific circumstances, error anticipation or recognition, and tactical recovery are important in their cognitive and technical surgical training. Assessment of trainees' decision-making capabilities is the other indispensable component to surgical skills training, and special emphasis needs to be placed on decision-making in knowledge- or information-constrained settings.

The contemporary mandate of surgical education is embodied in the challenge to provide training in decision-making and technical skills outside the normative center of textbook practice and in an environment of decreasing surgical time and patient exposure. It is into this void that the proponents of simulators and other patient surrogates are mobilizing their technologies. In addition, surgical education is now newly focused on the creation of "safe systems," not just on individual performance.

In this review, the concept of surgical error is explored, use of objective assessment to minimize errors is discussed, and efforts to incorporate or expand the use of objective surgical assessment in surgical education are touched on.

How is surgical error defined?

The Institute of Medicine defines error as "failure of a planned action to be completed as intended" (ie, error of execution) or "use of the wrong plan to achieve an aim" (ie, error of planning).[1] So, the term *surgical error* encompasses technical error and errors in perception, judgment, interpretation, communication, and system failure (details below). The Defense Advanced Research Project Agency (DARPA) sponsored a Conference on Surgical Errors (COSE) consensus meeting in Washington, DC in March 2004, which was attended by surgical leaders from the English-speaking colleges of surgeons. One conclusion arising from this meeting was that deviations from optimal performance are better characterized by the term *event*, than by the term *error*. There was agreement that the term *error* carries many connotations and lends unnecessary confusion to the process of training and assessment. Specifically, there was concern that reporting and discussion of errors or events that have minimal or no clinical consequence in mortality and morbidity rounds are essential to the process of training, but could cause confusion by generating counterproductive perceptions in the lay community about surgical errors. So, the following classification of events, based on severity of consequences, was proposed:

Minimal. A deviation from optimal performance that does not alter the course of the operation, procedure, or patient care, eg, placing a clip on a cystic duct that is not perpendicular to the duct

Minor. An event that briefly alters the course of the operation, procedure, or patient care, prompting maneuvers to deal with the consequences from the event, but the ultimate course of the operation, procedure, or patient care is not affected, eg, tearing the

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Abbreviations and Acronyms

ABS = American Board of Surgery
ACGME = Accreditation Council for Graduate Medical Education
ACS = American College of Surgeons
APDS = Association of Program Directors in Surgery

gallbladder and spilling gallstones that must be retrieved

Major: An event that alters the ultimate course of the operation, procedure, or patient care, eg, a common bile duct injury during a laparoscopic cholecystectomy

Errors may stem from failures of perception (including biases, collectively known as cognitive dispositions to respond),[13] cognition (knowledge and decision-making), and execution (mistakes).

Errors of perception

In radiology, failures of perception were postulated as early as the 1960s by Tuddenham[14] as a more prevalent cause of errors than failures of cognition.[15] "One cannot interpret a shadow he has not perceived," he stated, "and failure of perception must, therefore, account for a substantial fraction of all of our diagnostic errors." In a 2003 analysis of laparoscopic bile duct injuries, Way and associates[16] exposed the pervasiveness of errors of perception during this procedure, most notably, "an illusion of object form due to a specific uncommon configuration of the structures and the heuristic nature (unconscious assumptions) of human visual perception," which resulted in "a dissection too close to the common hepatic duct" and subsequent Class II injuries.[16]

Data from this analysis led the authors to conclude that the laparoscopic bile duct injuries stemmed from errors of perception more than from any other type of error.[16] "The misperception was so compelling," the authors stated, "that in most cases the surgeon did not recognize a problem. Even when irregularities were identified, corrective feedback did not occur, which is characteristic of human thinking under firmly held assumptions [bias]." To further elucidate this concept, Way and colleagues cited Reason's 1990 book, *Human Error*, which states, "the price we pay for . . . automatic processing of information is that perceptions, memories, thoughts, and actions have a tendency to err in the direction of the familiar and the expected."[17]

Errors of cognition

Errors of cognition in medical practice, considered in depth by Satish and Streufert,[18] have been assessed in surgery using objective structured clinical examinations (OSCEs) and the Observational Clinical Human Reliability Assessment (OCHRA)[19] and by using cognitive factors from aviation.[20] A literature search performed as part of a recent review by Yule and coworkers[21] revealed four main nontechnical skills categories: communication, teamwork, leadership, and decision-making. Although surgical governing bodies in both the United States and United Kingdom have identified the importance of including nontechnical skills training in surgical education, these skills are only just beginning to be analyzed and assessed. Surgical decision-making, the subject of a book currently in its fifth edition,[22] is a subject of primary concern to leaders in surgical education.

As discussed by Schön,[23] well-defined problems in surgery are rare; more common are ill-defined ones, in which information is unclear or many choices are evident. In a 2004 article in the journal, *Evaluation and the Health Professions,* Charlin and van der Vleuten[24] described an approach to solving ill-defined problems, ie, "reasoning in contexts of uncertainty." The approach consists of presenting a situation in which several options may apply, formatting responses in a Likert-type scale that reflects information processing during problem solving using script theory, and scoring based on aggregate methods to incorporate various reasoning processes identified in experts. This approach, concluded the authors, can differentiate the problem-solving efficacy of experts and novices, facilitating measurement of this cognitive domain.

According to Zabolotny and coauthors,[25] experts can be defined as those who "possess elaborate networks [scripts] of knowledge fitted to the tasks they regularly do." Script theory holds that, when faced with a clinical situation in which a decision must be made, clinicians call up from memory possible relevant solutions, and then use deductive reasoning to accept or reject each possibility. A way to measure this process, known as the script concordance test, has been developed; it assigns numerical values to the decision paths.[25] A script concordance test based on the American Board of Surgery (ABS) objectives for residency was recently validated as a successful discriminator between novice and expert intraoperative decision-making.[26] An online version was created and validated by French physicians for urology training[27]; the basic question and answer grid format for diagnosis and treatment (adapted from Sibert and colleagues[28]) is shown in Table 1.

In 2001, Satish and associates[29] reported on a simulation that contained decision-making tasks. Results of the study led the researchers to conclude that "the role of critical thinking in surgery should be enhanced . . . and is particularly relevant to dealing with complex and unanticipated

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