In Brief

Competence in surgery requires technical skill proficiency to perform the manual tasks that are often the centerpiece of the care of the surgical patient. It could be argued that, over the last several decades, there has been an underemphasis on the technical aspect of surgery and that, in a parallel fashion, methods of the assessment of technical competence have lagged behind other areas of assessment. The present situation is one that is filled with a discussion of medical error and strategies to mitigate error. For the surgical community, this will mean taking a hard look at the teaching, testing, and conducting of surgical operations and their outcomes.

In this monograph, motivating factors that lead medical students to choose surgical careers and elements that lead to a recent decline in the interest in surgery as a career choice will be described. The process of the selection of prospective aspiring surgeons and the potential usefulness of psychometric predictors of success will be discussed. This will be followed by an analysis of current methods of teaching and testing technical skills. We present a comprehensive analysis of work that has been accomplished in the educational sphere as it relates to the technical aspect of training a surgeon.

Surgery may be beginning to lose some of its appeal as a career choice. Recently, some surgical residency programs have had difficulty filling all of their training positions, and there has been a trend to go lower on rank lists to fill surgical residency positions over time. There are several potential explanations for this phenomenon. First, although stereotypic perceptions of the surgical persona may be unfounded, these student perceptions may exercise nevertheless considerable influence on career decisions. Second, women compose at least one half of medical school graduates but are considerably less likely than men to undertake surgical electives and choose careers in surgery. Third, the perception of surgery as a specialty with a "noncontrollable lifestyle" has had a dramatic effect on both the attraction of applicants to surgical specialties and the retention of residents in training programs. Fourth, in the past decade, medical schools have begun to encourage their students to pursue careers in primary care and, concomitantly, there has been a substantial decline in obligatory clerkship rotations in surgery. Finally, a relationship between clinical experiences and subsequent career selection exists in large part because of an exposure to mentors and role models. Some of the responsibility for the decline in interest in surgery may rest with surgical faculty who, in response to drastic tightening in

reimbursement, have paid less attention to their duties as career counselors and teachers and more attention to the restraints imposed on their practice by managed care. It has become incumbent on surgical educators to evaluate their programs and to determine whether changes have been made to address these issues, and if so, whether they have been transformative or merely cosmetic.

Effective selection of aspiring surgeons is critical to the profession. Traditionally, the selection process in surgery has relied on past academic performance, an unstructured interview, and a few personal references. However, the validity and reliability of such processes have been heavily criticized for years. In a domain that has often been compared and contrasted to surgery, "aptitude testing" has been successful in the selection of future pilots. Similarly, several studies have examined the pre-entry variables or aptitudes of surgical applicants, in an attempt to predict future performance. Some have yielded potentially useful results; others have not. By and large, research has shown that variables such as demographic information, cognitive knowledge, and manual dexterity fail to predict surgical ability, whereas high-level visual-spatial ability appears to be the most consistent predictor of future surgical performance. If the prediction of surgical performance is to be an achievable goal, it will be necessary to define appropriate outcome measures that can reliably assess the qualities that we consider important in surgical competence. Far more investigation in this area is required to reach a level of sophistication that can be compared to the selection methods used by flight training schools.

Numerous theories help explain the acquisition of technical skills in surgery, and an understanding of these theories proves beneficial for the development of teaching interventions. In combination, they highlight the importance of modeling, repetitive practice, and formative feedback. Modeling describes the process by which an instructor executes a task and then provides the novice with a cognitive understanding of that task. Repetitive practice is crucial for novices to acquire a complete understanding of a given skill and is also the key in the development and maintenance of expertise. Formative feedback is vital so that the trainee may gradually progress to independent performance. This feedback is gained both through the learner's own sensory channels during the execution of a task and by an expert instructor.

Before the last century, surgeons learned their craft through preceptorship. At the turn of the century, Sir William Halsted introduced a system of residency training with an emphasis on graded responsibility, which remains the cornerstone of surgical training programs today. However, new external factors have begun to challenge this traditional surgical education model.

Fiscal restraints have generated increased pressure to keep "turnover" in the operating room high, which allows less time for teaching and less opportunity for the learning and practicing of surgical skills. An explosion of medical knowledge and new technologies has increased the complexity of surgical practice. Patients with very serious and complex surgical problems that demand the skill of expert surgeons increasingly populate our teaching hospitals. Societal influences have affected surgical education, and it is clear that the public will not accept trainees learning basic surgical skills, for the first time, on live patients. Finally, the operating room itself may not be an ideal educational venue. Concerns regarding patient safety and time constraints often take priority over educational objectives; the learning experience cannot be standardized, and the operating room is often a stressful and hostile environment. As a consequence, surgical educators have begun to advocate for the need to develop approaches to teaching surgical skills outside the operating room. Supplementary courses and workshops in surgical technique for trainees were organized and held as early as 1962. Many residency programs have also added adjunctive training opportunities and/or curricula in specifically designed surgical skills laboratories. In these settings, basic surgical skills are learned and practiced on surrogate models, with the aim of better preparing trainees for the operating room experience. Inanimate surgical models, virtual reality modules, live animals, and human cadavers are used to simulate living human tissue. Such laboratory-based surgical skills training has been shown to produce immediate improvements in performance on the particular surgical tasks taught. However, there remains little evidence for its effect on performance in the long term or, most importantly, its effect on surgical performance in the operating room.

Any method of teaching technical skills should be evaluated before its widespread implementation. Several considerations should guide a decision about the most appropriate method of assessment. The essential tenets of a psychometrically sound test are reliability and validity. An ideal assessment instrument would also possess each of the following: feasibility, comprehensiveness, flexibility, timeliness, accountability, and relevance to the examiner and the examinee.

When attempting to "measure" surgical competence, one must remember that it is composed of two major components: cognitive skill, which includes knowledge and decision-making, and the other technical skill. Obviously, both aspects are essential, but proven assessment tools are already available to measure the cognitive aspects of competence. It is the technical aspect that currently suffers from poor assessment strategies. In most training programs, formative assessment presently occurs with the use of in-training evaluation reports, which are periodically completed at

various intervals during training. Summative assessment occurs with the combination of oral and written examinations. Often, the unstructured feedback from an in-training evaluation report can be valuable to a trainee. However, as a method of formal evaluation, in-training evaluation reports have been widely criticized in many arenas. Although written and oral examinations may be touted as adequate measures of cognitive knowledge and survive as "rites of passage" to a specialization in surgery, neither type of examination attempts specifically to measure technical skill. The major assessment techniques that have been or could be used to measure technical skill can be grouped into five categories: (1) procedural logs (traditional logbooks, personal digital assistants, cumulative sum analysis), (2) observation without criteria (general impressions, forced choice ranking), (3) observation with criteria (objective structured assessment of technical skills, videotaped performances, final product analysis), (4) computer-aided assessments (motion analysis, virtual reality), and (5) multidisciplinary and/or multidimensional assessments.

Before the implementation or development of any method to evaluate technical skills, serious consideration should be given to each of the "ideal qualities" of an assessment instrument. A thorough description of each assessment method, combined with its inherent strengths and weaknesses, can be found in the main text of this monograph. In general, however, the more objective, standardized, and structured the criteria for assessment, the more reliable is the process. Validity is often proportional to the realism of the simulation. Feasibility and cost of an assessment are also major considerations. The purpose of the assessment will ultimately define the rigor with which reliability and validity issues prevail and determine the level of acceptance of an expensive and logically complex assessment.

Not only are these issues important for the training and certification of aspiring surgeons, but they are also becoming increasingly important for practicing surgeons. At present, societies, hospitals, and licensing bodies all rely heavily on surgeons' assessments of their own skills and limitations to make appropriate decisions inside and outside of the operating room. An example of the fallibility of this approach may be encountered when practicing surgeons undertake to learn and perfect new techniques. With the widespread introduction of laparoscopic techniques in the late 1980s, an associated 2- to 3-fold increase of bile duct injuries followed. The explosion of new technologies has mandated a review of certification issues and has led to a realization that lifetime licensure may not be in the best interest of society or the profession. As such, periodic reassessments may become reality in the very near future. And, just as airline pilots are expected to demonstrate ongoing maintenance of

competence, so too will practicing physicians and surgeons be required to do so in a similar and rigorous way.

The rapid advances being made in medical science and technology in our current age will likely be accompanied by dramatic changes in the way surgery is taught and delivered in the future. We are also quickly moving from a world of open surgery, where tactile feedback plays a vital role, to a minimally invasive world where other forms of sensory feedback are vital to surgical performance. This paradigm shift may have dramatic implications for the way we select surgeons, develop programs of surgical training, and certify and recertify surgeons.