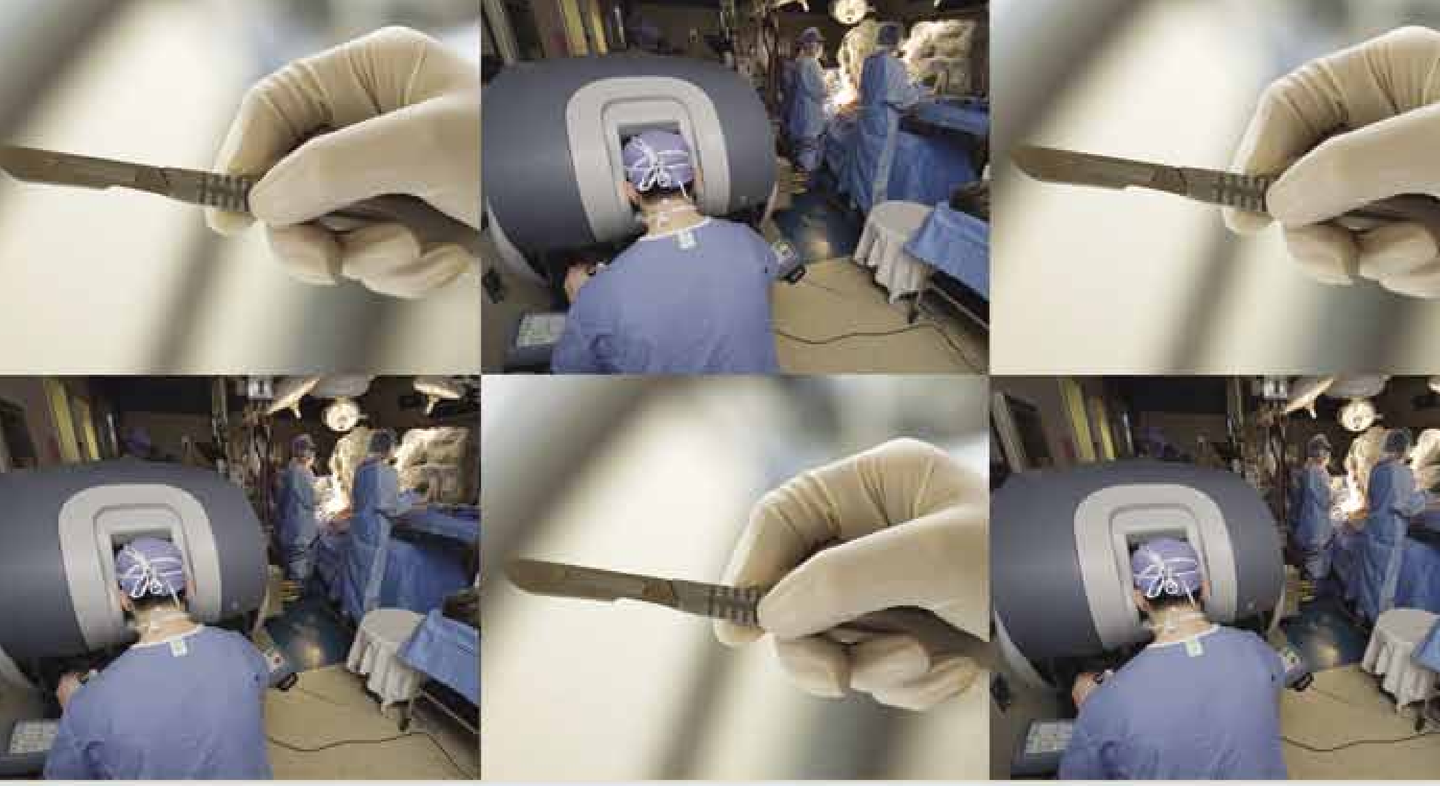

# From scalpel to console:

## A suggested model for surgical skill acquisition

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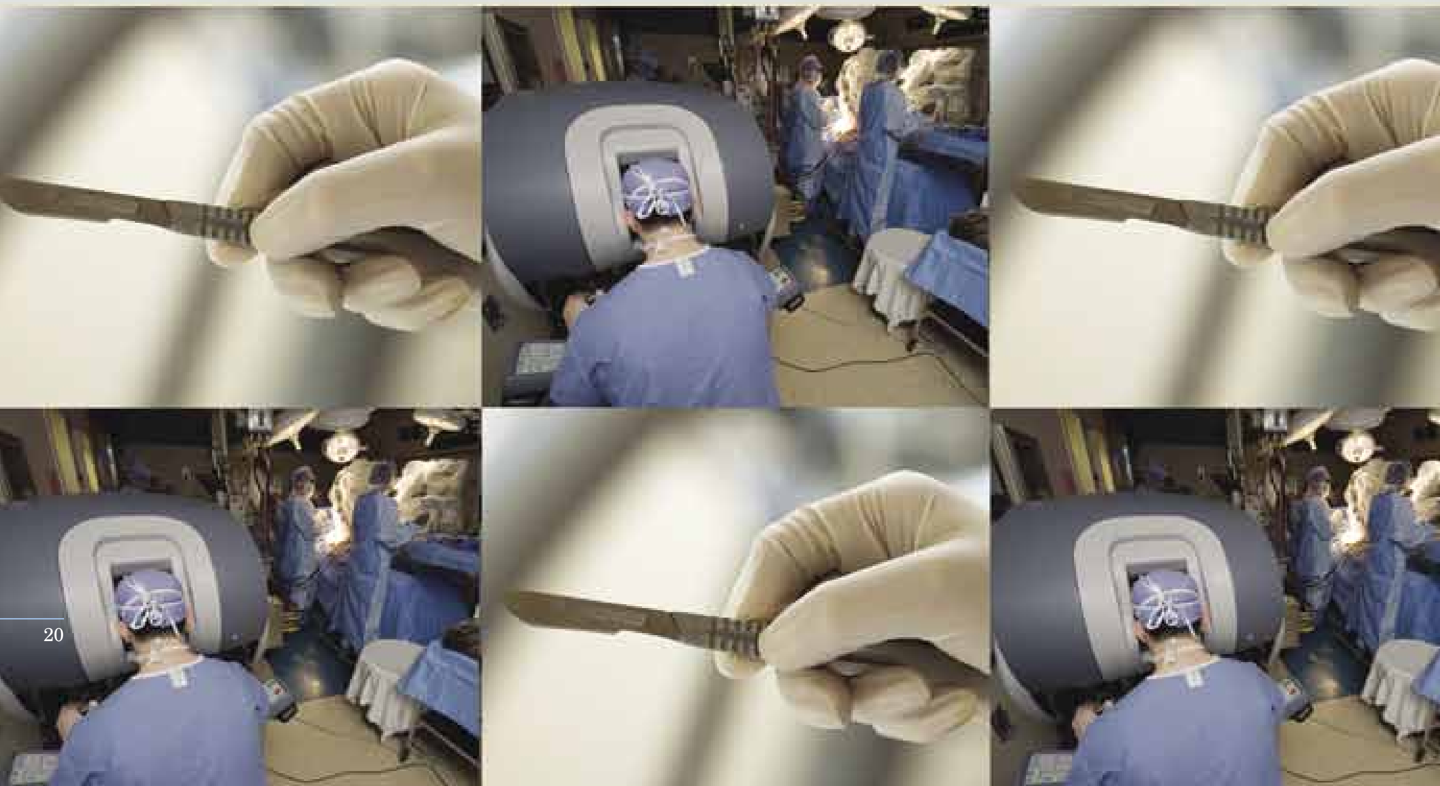

In 1987, a major revolution occurred in the practice of surgery: the advent and incorporation of minimally invasive laparoscopy, laparoscopic cholecystectomy in particular, into clinical surgical care. The technique was disseminated quickly, but the initial results were disastrous. The traditional surgical skills used in open surgery with three-dimensional visualization did not translate immediately to the skills needed to perform the operation with new instruments, while visualizing the procedure in only two dimensions on a computer screen. Furthermore, patient safety was not prioritized, and training was haphazard. The result was compromised outcomes.[1] Bile duct transactions, which had become a rarity in open cholecystectomy, were now commonplace with the advent of this new technology. Between 1993 and 1996, 629 trocar-related injuries were reported to the U.S. Food and Drug Administration, and many more likely occurred. Those reported injuries included more than 30 patients deaths, with nearly 500 vascular and visceral injuries.[1]

## Robotic surgery

Another surgical revolution in now under way: robotic surgery. As we embrace this new technology, we must balance surgical progress with safety and efficacy. In 1994, the American College of Surgeons' (ACS) Committee on Emerging Surgical Technology and Education established principles for the safe implementation of surgical technologies. Although the committee acknowledged that the process of evaluating new technologies should not impede their timely development or use, the committee emphasized the importance of establishing the value of a procedure prior to its widespread use on patients.[2] The purpose of this article is to describe what we believe is a safe means of surgical skill acquisition.

Safety—in the discipline of surgery—depends on interactions between people, machines, and working conditions. Performing safe procedures is the conglomeration of multiple learned skills and, thus, involves practice to achieve mastery. The learning curve for surgical procedures is considered to be the number of cases needed for a surgeon to reach the level of expert, and that further repetition of the procedure will not yield any additional improvement in surgical skills. Unfortunately, there are no standard guidelines regarding safety measures that shorten a surgical learning curve or make it less steep.

## Surgeon learning

Several methods of learning can be utilized for continuous surgical education. One means is preceptorship, a form of training whereby an experienced surgeon supervises a procedure with the intention of guiding the learner in the acquisition of new skills. Preceptorship is distinctly different from proctorship, in which an observer is merely responsible for assessing skills and knowledge.[3] Simulation training on technical skills and performing new procedures (first on cadavers) are reasonable options for instructing surgeons, but transferring the new skills into live patients is user-dependent, and does not directly correlate with technical training.

When training is inadequate for a procedure involving advanced technology, as was the case in early training on laparoscopy, failures occur. In complex procedures that involve both expertise and technical competence, systems interruptions are common. Most of these failures result from insufficient preparation. A recent retrospective review of closed malpractice claims supports the theory that most adverse events are due to systems malfunction.[4] Of the 444 claims reviewed, 75 percent of errors arose intraoperatively, and system failures contributed to 82 percent of the adverse outcomes. The most frequent causes of adverse outcomes were inexperience and lack of technical competence.

Several authors have addressed the issue of how to systematically and safely introduce new technology and skills into surgical practice. Ajit K. Sachdeva, MD, FACS, FRCSC, Director of the College's Division of Education, proposed general principles for the safe introduction of new procedures after the period of residency and formal training.[5,6] The principles are based on the level of evidence available to support a new procedure, the practice patterns of the surgeons,

Opposite: Robotic surgery photo copyrighted and used with permission of Mayo Foundation for Medical Education and Research, all rights reserved. Scalpel photo courtesy of istockphoto.com.

and the needs of the community. Because practice patterns directly influence risk, practice guidelines have been suggested for achieving and maintaining certification.[4] The incorporation of new devices into surgical practice should be disease-based, not a technology-driven application. Dr. Sachdeva proposed the idea that skill acquisition should extend to the entire surgical team, and not just the primary surgeon.[6] Embracing the team approach is a mechanism by which multiple experienced surgeons can learn as a group and serve as preceptors to each other.

Jonathan Meakins, MD, FACS, well known for his contributions in patient safety, once stated, "…in many fly-by-night programs, the surgeon took the course on the weekend and had patients booked on the following Monday. This is not the way to do it, and it is unlikely that society will tolerate such a cavalier attitude."[7] Prerequisites for introducing new surgical techniques should include the following: in-depth knowledge of the relevant disease process and its management gained through formal training and clinical experience, the acquisition of new skills, the development of appropriate support facilities, completion of a defined didactic educational program in the technology, assessment by a qualified surgeon experienced in the technology, and periodic monitoring of skills and outcomes. Furthermore, when a new technique becomes widely used, it must continue to be assessed and compared with alternative therapies to ensure efficacy and cost-effectiveness.[2]

## Preceptorships

In 2006, surgeons in the Surgical Endocrinology Section at The University of Texas M.D. Anderson Cancer Center, Houston, TX, were encouraged by a senior mentor to explore the benefit to patients of posterior, retroperitoneoscopic adrenalectomy (PRA). The world expert in PRA is Martin Walz, MD, an experienced endocrine surgeon in Essen, Germany. The M.D. Anderson team, composed of three faculty surgeons and one surgical oncology fellow, traveled together to Essen for on-site observations of multiple PRAs performed by Dr. Walz and his surgical team.

In a PRA procedure, the adrenal gland is approached laparoscopically, from the posterior approach. The procedure requires a reorientation to the regional anatomy (which surgeons typically view anteriorly), modified patient positioning, and equipment that is typically unfamiliar to the surgeon. We introduced the technique into clinical practice as a team approach. This approach allowed each individual surgeon to learn, but each surgeon also served as a preceptor to the other team members, and allowed us to work together to solve problems as they occurred.

Results of our initial series of 62 cases were reported at the American Surgical Association's annual meeting in 2008.[8] We had no perioperative deaths, and no reoperations were required; outcomes such as blood loss were acceptable for the complexity of the cases. When the patient population was divided into earlier and later cases, the median operating time did not differ significantly between the two subgroups. We believe that this finding resulted from a successful team approach, which allowed the risks of the learning curve to be flat because of the shared experience.

From our experience gained with the PRA procedure, we suggest that the model of group learning for skill acquisition can be used for the safe implementation of other modalities and procedures involving other organ sites. It is also suggested that this method is sufficient to fill in the gap when surgeons are serving as entrepreneurs, in order to push the envelope where no strong national precedent has been set—without compromising patient safety.

## A model for introducing new technology

We then applied our model of group learning to the implementation of robotic surgery for transaxillary thyroidectomy. We became familiar with the literature on robot-assisted transaxillary endocrine surgical procedures, and then committed to exploring the technique. We identified a team consisting of experienced, dedicated endocrine surgeons, a biomedical engineer, and a technical support expert. With the approval of our department chair, we discussed access to, and availability of, our institution's robotic equipment (Intuitive Surgical Inc., Sunnyvale, CA) with the medical director of the minimally invasive new technology in the oncologic surgery group. All team surgeons acquired robotic console skills after more than 10 hours each of simulation training and completion of online training modules. The group then traveled together to Seoul, South Korea, to learn the procedure from a surgeon, C.Y. Chung, MD, the individual with the most robotic transaxillary endocrine surgery experience in the world. We interacted with Dr. Chung's operating team, including nurses, fellows, and anesthesiologists, and we repeatedly observed operating room set-up, patient positioning, incision placement, instrument assignment, as well as operations. We then traveled to the robotic manufacturing headquarters in Sunnyvale, CA, to interact with the engineers of this device in order to master the equipment.

After returning to M.D. Anderson, we reviewed the open surgical dissection technique for transaxillary dissections, which is similar to the techniques of subcutaneous, skin-sparing mastectomy and axillary lymph node dissection. We re-mastered the anatomy of the lateral cervical approach. We then, as a team, performed robot-assisted dissections on multiple cadavers. We defined a best-practice algorithm that included each step of the procedure, and created a checklist to ensure safety and efficiency. We broke the procedure into responsibilities for three team members—designated console surgeon, field surgeon, and tower surgeon. All team surgeons developed competency in each role. To provide an efficient and concise means of communication, we created and memorized a technical vocabulary that defined what we meant by words such as extender, align, insert, deploy, and mount. Preparations for potential system failures were discussed, and strategies planned, to prevent collapses. We all became familiar with the instruments, whether or not they could be reused, and the cost of each item. All team members practiced emergency removal and deployment of the robotic devices. Dedicated operating room staff, including an anesthesiologist and a physical therapist, were identified, and the operating room personnel were prepared for the expectations pertaining to availability of light sources, bolsters, suction devices, retractors, and laparoscopic instrumentation.

Research aims were established, and data acquisition forms with definite endpoints were designed. A commitment was made to employ the technique with continuous refinement. Patient selection criteria, with particular attention to landmark anatomy, were established. We performed the initial cases as planned, with a team consisting of console, field, and tower surgeons. A master log of outcomes was maintained, and periodically reviewed, by all team members.

## Implementation

We believe that the model we followed can be applied by other surgeons in order to learn any robotic procedure. By following a well-defined process, surgeons can safely employ a new technology-based skill into clinical care. Techniques for overcoming obstacles to the delivery of safe surgical care have been designed by the ACS Committee on Emerging Surgical Technology and Education by learning from past failures.

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When new technology is involved, we should ask ourselves: Are we, as surgeons, following the principles of evidenced-based medicine? These include (1) defining the question and the problem, (2) searching for evidence, (3) applying the results, and (4) auditing the outcomes.

The safe implementation of new technology is a tremendous responsibility. William Mayo, MD, FACS, made a wise observation 100 years ago when he said, "There is no excuse today for the surgeon to learn on the patient."[9] Alexander Walt, MD, FACS, Past-President of the American College of Surgeons, has been quoted as saying, "The concept that one citizen will lay himself horizontal and permit another to plunge a knife into him, take blood, give blood, rearrange internal structures at will, determine ultimate function, indeed, sometimes life itself—that responsibility is awesome both in the true, and in the currently debased, meaning of that word."[10] We are reminded by James Jones, MD, that "As surgeons we, as fiduciaries, must balance technologic advancement and ethical responsibilities, a subject rarely broached in our data-driven surgical publications."[11] Ω

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