

# A New Paradigm for Surgical Training

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The once immutable apprentice model (“see one, do one, teach one,”) for surgical training—developed by Dr. William Halstead in the early 20th century<sup>1</sup>—is no longer unquestioned. After the 1999 publication of “To err is human,”<sup>2</sup> the Institution of Medicine challenged teaching institutions to devise alternative methods of surgical training. After Bridges et al.,<sup>3</sup> also in 1999, estimated the financial impact of teaching surgical residents in the operating room (OR) to be \$53 million per year, a second incentive for change came to light, soon followed by the 2003 institution of the 80-hour work week restrictions.<sup>4</sup> Coincidentally, patient safety concerns (and medical malpractice cases) related to laparoscopic procedures being performed by surgeons more comfortable with open procedures was raising another red flag in surgical training.

In response, partial task training and medical simulation have gained credibility as alternative and complementary methodologies for surgeons needing to master or polish both technical and communication skills. Outside of the OR, surgical simulation and skills training offers a safe compliment for improving quality and efficiency of teaching and learning procedures.

## Simulator Based Training

Minimally invasive surgery imparts new challenges for the surgeon. Operating in a three-dimensional field with a two-dimensional visualization demands much different psychomotor skills. Haptics, tactility, and ergonomics of instruments—as well as the OR set up—may be a challenge for a novice in the field and requires a steep learning curve for proficiency. Patient safety concerns have reduced the trainees ability to acquire surgical skills by “practicing” on patients in the OR. Therefore simulator training has emerged and offers surgeons a safe alternative for learning laparoscopic skills.

Current technology offers a variety of tools to help with task training. The realism and scope of task trainers is rapidly expanding. Simulation tools can be labeled as *physical reality* systems that include box trainers and animal models, *virtual reality* (VR) systems that are software-based, and *mixed reality* trainers that are a combination of video equipment and electronic sensors that are activated upon touching physical objects with instruments. The simulation tools can be used for part-task training of basic to complex skills that occur during surgical procedures, for example suturing or dissection. Full procedural simulators enable the user to practice integrating different skills into a continuous procedure. The latest emerging field is the concept of integrating part-task training and procedural simulator training with team training in simulated operating rooms where trainees have an opportunity to rehearse skillful handling of emergency situations.

*Box trainers* offer a number of drills that can be practiced using real instruments and even cadaveric tissues, however the face validity of these models is poor and their application specifically towards bariatric procedures is still in development. The Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) uses the box trainer for certification in Fundamentals of Laparoscopic Skills (FLS).<sup>5</sup> Although not required, FLS certification is recommended by SAGES for all senior residents in General Surgery and may represent a benchmark for surgeons performing laparoscopic procedures. As part of a patient safety initiative in 2008, CRICO/RMF is offering a premium insurance discount to surgeons after successful completion of FLS.

*Animal models* as well as *cadaveric models* are used for laparoscopic surgery training courses. Much of the porcine foregut anatomy is similar to the human anatomy and therefore this model provides high fidelity. In addition, animal lab operating suites offer the opportunity for trainees to work in teams more closely approximating procedures on humans. Ethical restraints, as well as costs, are limiting the use of animal models for wide scale procedure training.

*Virtual reality* (VR) represents a novel avenue for laparoscopic surgery training. Although sophisticated simulators are available commercially and provide higher face validity than box trainers, they are still in relatively early stages of development. VR provides an opportunity to practice tasks and entire procedures in a way that trainees not only learn technical skills but also key steps of procedures. However, one major limitation of VR simulators is their lack of haptics (touch). Force feedback mechanisms are currently being integrated into newer simulators. Some of the endoscopic procedure simulators have a more developed haptics feedback mechanism. They are based on a common platform with real endoscopes introduced into an elongated box in which the travel of the end-piece activates progressive views of anatomy or specific haptics responses. One criticism of VR simulation is that graphics remain ‘cartoonish’, however they are also expected to improve with time. One of the VR simulators currently available for laparoscopic surgery,<sup>6</sup> the LAP Mentor (Simbionix) has developed a library of modules that contain part-task and procedure-specific virtual reality training cases. Each part of the procedure is broken down into several critical steps that are described and the surgeon can perform them using virtual tools.

## Operating Room Team Training

Beyond part-task trainers and VR procedure simulators, team training in virtual ORs is being developed to enable the learner to practice more comprehensive laparoscopic surgery scenarios. Virtual ORs target higher level skills that enable the surgeon to not only perform a surgical task, but interact in a health

care team environment—simulating a real OR. Traditionally, quality patient care was believed to result from being well trained in a particular set of individual skills. Unfortunately, even skilled, experienced providers will make mistakes, which are often viewed as personal failure, with the predictable result that these events are minimized and not openly discussed. Human factors research suggests that surgical outcomes are not only a result of an individual's skill but also a result of complex interactions of health care personnel working as a team, all of whom are influenced by the environment in which they work in. A report from the Joint Commission revealed that in more than 70 percent of 2,455 sentinel events reported, the primary cause of medical error was communication failure.<sup>7</sup> Reflecting the seriousness of these occurrences, approximately 75 percent of these patients died. As in aviation and other industries, steps to circumvent error via team training have been implemented (and are often mandatory). Crisis simulation team training in surgery using a simulated operating theater was first described in the United Kingdom by Sir Ara Darzi.<sup>8</sup> That scenario assessed the trainee's technical ability to control femoral arterial bleeding as well as team/human factors skills such as: communication, situational awareness, and team and leadership skills during a crisis.

*Virtual endosuites* are a novel concept that is currently being developed. The first virtual endosuite used for laparoscopic skills training has been established at the Beth Israel Deaconess Medical Center. The Carl J. Shapiro Simulation and Skills Center,<sup>9</sup>—accredited as a Level I Education Institute by the American College of Surgeons—provides simulation-based skills training to health care students and professionals from all medical and surgical disciplines. SASC's mock endosuite replicates a real operating theater.<sup>10</sup> All standard laparoscopic surgical equipment, as well as an anesthetic simulator, is present and allows manipulation of the mannequin's hemodynamic parameters through a software program. Video and audio recording equipment allows the researchers or trainers to view

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the simulation in real time as well as via playback on a DVD disc to evaluate or use for debriefing. A synthetic model of the abdomen is fixed to the anesthetic simulator which simulates the abdominal wall skin as well as intraabdominal organs and fat. The model is draped with surgical drapes and simulated laparoscopic procedures can be performed and simulated blood loss initiated, controlled, and monitored.

Although surgical simulation has limitation, the field is undergoing growth and transformation at an exponential rate. Simulators, even in their current form, have been demonstrated to improve laparoscopic surgical skills. In the era of increased patient demands for safety and a change in health care culture from an individual expert physician to collaborative team environments, surgical simulators have an enormous potential to develop into standardized training programs for laparoscopic and other surgical procedures. Even with its limitations, simulation should prove to be a powerful surgical training and planning tool. ■

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