Simulation Training in Video-assisted Urologic Surgery

András Hoznek, MD, Laurent Salomon, MD, Alexandre de la Taille, MD, René Yiou, MD, Dimitrios Vordos, MD, Stéphane Larre, MD, and Clément-Claude Abbou, MD

Corresponding author
András Hoznek, MD
Service d’Urologie, Centre Hospitalier Universitaire Henri Mondor, Université Paris XII, 51, Av ; du Ml. De Lattre de Tassigny, 94010 Créteil-cedex, France.
E-mail: andras.hoznek@hmn.aphp.fr

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The current system of surgical education is facing many challenges in terms of time efficiency, costs, and patient safety. Training using simulation is an emerging area, mostly based on the experience of other high-risk professions like aviation. The goal of simulation-based training in surgery is to develop not only technical but also team skills. This learning environment is stress-free and safe, allows standardization and tailoring of training, and also objectively evaluate performances. The development of simulation training is straightforward in endourology, since these procedures are video-assisted and the low degree of freedom of the instruments is easily replicated. On the other hand, these interventions necessitate a long learning curve, training in the operative room is especially costly and risky. Many models are already in use or under development in all fields of video-assisted urologic surgery: ureteroscopy, percutaneous surgery, transurethral resection of the prostate, and laparoscopy. Although bench models are essential, simulation increasingly benefits from the achievements and development of computer technology. Still in its infancy, virtual reality simulation will certainly belong to tomorrow’s teaching tools.

Introduction

Because of increasing expectations toward surgical performance, budget restrictions, and increased sensitivity to medical legal considerations, the surgical profession is constantly looking for innovative training systems that are efficient, reliable, and validated.

Should surgery be learned only inside the operative theatre? The long-held apprenticeship model described by William Halsted is based on the philosophy of “see one, do one, teach one” and relies heavily on random chance and opportunities for surgical education. This system does not allow the standardization of training curriculum and becomes more and more difficult to apply in the modern teaching.

In the past few years, three fundamental principles have been increasingly emphasized in surgical education:

1. Clinical practice should meet the requirements of evidence-based medicine,
2. Patient safety aspects are increasingly stressed,
3. Surgical training uses simulation,
4. Simulation is not new.

Simulation is not new. It has been used for many years for the training and assessment of technical and team performance of aviation and military personnel during work in hazardous environments. There are many similarities between pilots and surgeons; both have to deal with stressful and critical situations that are often unpredictable. The advantages of simulation observed in several fields of industry have prompted surgeons to bring simulation into medical education.

Historic Background

In modern simulation training, Edwin A. Link provided a giant step forward when he developed his “pilot maker” training device in 1929 [1]. During World War II, 500,000 pilots received their flying training using the Link trainers.

In the field of medicine, simulation has been greatly encouraged by Safar et al. [2] who were interested in potential reversal of cardiac arrest. They experimentally demonstrated the efficacy of mouth-to-mouth ventilation. Inspired from this work, Laerdal shortly designed a full-size training mannequin known as Resusci-Anne, representing a victim who was not breathing and who did not have a heart beat. Its use rapidly spread around the world [3].

The first surgical simulator was developed in 1990 by NASA members Rosen and Delp, and consisted of a rep-
representation of a lower limb designed to practice tendon transplants for reconstructive surgery in gait disorders [4].

What Are the Elements of Surgical Skills?
Surgical competence is a result of technical and non-technical skills. Traditionally, training in surgery concentrated on theoretic and anatomic knowledge, spatial orientation, dexterity, and psychomotor skills required to perform an operation. This used the principle of apprenticeship, during which an experienced surgeon supervises a student. The apprentice practices on real patients and gradually learns to perform the procedure autonomously. In this teaching modality, for any mistake, it is the patient who has to pay the price. It also has been shown that developing technical skill using the operating room is inefficient, more time-consuming, and expensive [5]. Bridges and Diamond [6] estimated that in the United States, 53 million dollars are spent annually in additional operating room costs for training surgical residents, translating into $48,000 for each graduating resident.

However, the technical skills account, to a certain extent, only for an expertly performed surgical procedure. Experience in high-risk industries shows that adverse events are primarily due to human failures and it is not usually a lack of technical expertise that is responsible.

Non-technical skills are greatly responsible for maintaining safety and adequate crisis management. They can be organized into five categories:

1. Situation awareness, which is defined as the ability of gathering and understanding information, allowing anticipation,
2. Decision-making, which is defined as the ability to consider and select options, implementing and reviewing decisions,
3. Task management, which means organizing the resources, personnel, and activities required to achieve goals,
4. Leadership, which is defined as the ability to provide direction when necessary and being considerate about the needs of team members,
5. Communication and teamwork, which ensures that the team has an acceptable shared picture of the situation and can complete tasks effectively.

In the field of anesthesia, critical incident reporting and observational studies, both in the clinical setting and when using patient simulators, have identified non-technical skills to be major determinants of successful crisis management. Behavioral marker systems already are used in anesthesia for training in crisis management with repeated exposure to simulation-based education [7].

However, beyond these technical and non-technical skills, surgery is accepted as one of the most demanding professions that creates significant physical and mental strain on performers. There are periods of considerable psychologic tension during some operative procedures. Fatigue, operative difficulty, and previous experience were proposed as possible causes of sympathetic arousal of the surgeons [8].

The operative room is a suboptimal classroom in terms of stress-learning relationship, because it often is an exasperating environment [9,10]. There has been considerable work during the past century studying the effects of stress on learning potential, beginning with the studies by Yerkes and Dodson in 1908. The Yerkes-Dodson law is represented by an inverted U-shaped curve showing that as stress increases, so do learning efficiency and performance. However, there is a decline in performance when stress becomes too great. Modulation of stress in the learning environment should receive a great deal of emphasis. Reduction of student stress in the operative room may be accomplished through maximum preparation outside the operative room with the use of simulators. On the other hand, a moderate level of stress should be added to the simulation training system, because this is known to be the optimum psychologic learning context. Gradual exposure to the situation causing anxiety was used successfully in medical education, especially in the field of anatomy for students first dissecting a human cadaver [11].

Simulation using virtual reality technology has been employed in the field of psychiatry for the treatment of pathologic forms of anxiety such as acrophobia [12].

The Rationale of Simulation in Surgical Training
Simulation can be defined as a device or exercise that enables the participant to reproduce or represent, under test conditions, phenomena that are likely to occur in actual performance [13].

Advantages of simulation training over traditional medical education methods include the following: provision of a safe and stress-free environment for the patient and the student during training in risky procedures; repetitive exposure to rare but important or complex clinical events; standardization of training curriculum; the ability to plan and tailor training opportunities rather than waiting for a suitable situation to develop clinically; the ability to provide immediate feedback; the opportunity for team training; and lower direct and indirect costs

Assessment of Surgical Competence
Validated models and methodology
Surgical simulation is not only considered for training, but also for objective testing and credentialing in surgery. However, before being included as routine methods of surgical education, new simulation technologies should prove their effectiveness and reliability and be scientifically validated [14••]. Several criteria have been