

Review Article

The importance of simulation training in surgical sciences

Bernardo A. Fernández-Reyes, Ana K. Flores-González, Luis A. Alvarez-Lozada, Juventino T. Guerrero-Zertuche, Francisco J. Arrambide-Garza, Xavier G. Quiroz-Perales, Alejandro Quiroga-Garza*, Rodrigo E. Elizondo-Omaña, Santos Guzmán-López

Department of Human Anatomy, School of Medicine, Universidad Autónoma de Nuevo León, Monterrey, Nuevo León, México

Received: 01 April 2022

Accepted: 30 April 2022

***Correspondence:**

Dr. Alejandro Quiroga-Garza,
E-mail: dr.aquirogag@gmail.com

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ABSTRACT

Simulators have been used throughout history to practice complicated procedures before performing them on human beings. The earliest simulation attempts were in cadavers. Donor bodies are still used for teaching and research but involve costly infrastructure, ethical and legal issues, as well as animal models. Training models need to be purposefully designed. These can be physical models, 3-D printed, simulators with virtual reality, augmented reality, or a hybrid simulation. The inert model is an alternative for animal tissue models, based on a trial-and-error method, the learning curve is approximately 65 procedures for a laparoscopist. Simulations models with virtual and augmented reality have shown that can reduce the time of practitioners with experience in laparoscopy, with an approximate reduction of 30 to 58%. Video-based learning method has been adopted in recent years but has shown to be less effective than hand-on learning using a simulator. Simulation can be involved to simulate specific scenarios, recreate simulated trauma patients, help develop a doctor-patient relationship and prepare complex approaches. Patient safety concerns call for the need to train medical personnel in simulated settings to reduce cost and patient morbidity because the ability to acquire surgical skills requires consistent practice. Simulation represents ideal teaching methods to optimize the knowledge and skill of residents before they are entrusted with procedures with real patients.

Keywords: Simulation, Surgical simulation, Surgical training, Surgical education

INTRODUCTION

The phrase by Francis D. Moore states that- ‘You can’t learn to play the piano by attending concerts’.

The use of simulators has been used by novices and experts to learn, perfect, and simulate surgical skills for basic and complicated procedures. A surgeon can rehearse specific, uncommon, or difficult maneuvers before performing them directly on the patient. The earliest simulation attempts were with cadavers in the sixth century BC.¹ Currently, donor bodies are still used for teaching and research, however, these require costly infrastructure, and involve ethical and legal issues.^{2,3} Animal models have

similar challenges and must be rightfully justified.⁴⁻⁶ The use of technology-enhanced simulators and models has provided a viable option to imitate real-life scenarios and for learners to acquire experience and confidence.^{1,7,8}

Training models must be purposefully designed. These can be physical models, 3-D printed, simulators with virtual reality, augmented reality, or a combination of these for hybrid simulation.⁸⁻¹¹ These allow for a greater number of trainees to participate, and the repetition of maneuvers. However, the models do not depend only on their design. They must transfer knowledge and skills, develop confidence, precision, and decision-making, and have supervised performance for feedback and mentoring.¹²⁻¹⁵

HUMAN BODY MODELS

Dissection of the human body is considered essential in the unique ethical and technical formation of future physicians and surgeons, both in undergraduate and postgraduate medical education.^{6,16-18} Dissection is extremely useful in a variety of ways: it aids understanding of the three-dimensional organization of the human body, appreciation of the body, introduces the concept and demonstration of anatomical variability, develops practical skills, promotes teamwork, introduces students to the physician-patient relationship, reinforces familiarization with and respect for the human body, and establishes the concepts of humane care and understanding of the phenomena of death and of dying. However, due to elevated costs, many universities are decreasing funding for these types of laboratories.^{13,19}

Body donation programs for medical education and research are essential. However, many countries still lack the legal fundamentals to establish these, and those with well-established programs currently have the challenge of justifying costs and ethical issues.^{3,20-22}

ANIMAL MODELS

Animal models have been used in centers allowing trainees to perform complex laparoscopic procedures outside the clinical setting.^{23,24} The animals providing the organs usually are specially bred for these purposes elevating their cost, their anatomy may vary from human, along with the ethical implications it carries due to its limited use, and therefore are not used frequently.²⁵ However, there is a superiority in the use of these tissues. The similarity to human tissue brings elevates the fidelity, allowing detailed abilities to be developed. With the animal anesthetized, local and generalized complications and bleeding are incorporated into the procedure, providing value to the development of confidence in surgical training.^{7,13,26}

INERT MODELS

Synthetic models are anatomic but can be divided into those with life-like characteristics, and with non-life appearance. They provide an alternative for biological tissue models and are frequently used for basic surgical skills such as knot tying, suturing, and laparoscopic technique training.^{7,13,27} These models may increase simulation with added electronic components such as video, virtual reality, augmented reality, others. They may also include tactile feedback to increase fidelity and flatten the learning curve, making clinical settings safer. With costs of technology decreasing, these are available with greater ease, providing objective performance measurements, and reliable feedback.¹³

Mannequins and mechanical simulators have proven equivalent in terms of outcome for obtaining skills such as neonatal intubation, laparoscopy, animal anatomy, human anatomy, and training of emergency medical procedures,

such as insertion of a chest tube, and cricothyroidotomy, without the harmful use of animals.²⁵

Although these models include a high initial investment, they can be used with more trainees and for longer periods of time. These result in cheaper, durable, and readily available training that can be implemented in any training center.^{27,28} Training has been shown to reduce operating time and error while improving performance and confidence.^{10,23,29,30} However, structured training is needed, as formal training programs are still lacking.^{11,18}

VIDEOS AND WEBSITES

Video-based learning (VBL) integrates different teaching skills based on the technique “see one, do one, teach one.” This way, apprentices can be provided with knowledge through visualization, obtain feedback once encountering the skill challenges, and be exposed to understanding enough to teach others what was learned. Surgeons have embraced online videos for skills acquisition and case preparation.^{31,32} In recent years, surgical videos and video-based online platforms have increased rapidly, with worldwide reach, allowing viewers to learn and repeat videos in a safe environment, according to the time disposition, and learning pace. However, these must be used with caution. Studies examining content on YouTube, the most common source for surgical videos, report substantial variability in educational value due to nonuniform production quality, unclear intent (education or marketing), lack of a peer-review process, and many times suboptimal techniques and maneuvers.³³⁻³⁵

The learning method using instructional videos has shown to be less effective than hand-on learning using a simulator for microsurgery training, especially in understanding the procedure. However, traditional video instruction can increase the effectiveness of the training curriculum for novices when videos follow recommendations such as the LAP-VEGaS practice guidelines for surgical educational videos.^{36,37}

IMPLEMENTATION OF TRAINING

Simulation is a practice involved in many areas of medical education. It can be used to simulate patients with specific clinical scenarios, help cultivate doctor-patient relationships, recreate simulated trauma patients, prepare for complex approaches or anatomical variants, among others. These benefit the patient as well, primarily its safety.³⁸ Student and resident training with simulation prior to engaging patients decreases mala praxis. Users can learn and understand anatomy better and make fewer mistakes.^{39,40} Time is better spent with higher exposure and repetition which may be limited in the operating room due to restrictions both in residency duty-hours hospital protocols.^{1,41} Operating times can also be reduced due to practice and the confidence developed by the surgeon.^{11,40,42,43}

Although many programs around the world have implemented these strategies, resources in low- and middle-income countries may be narrow primarily in public institutions, with access to students and residents limited.^{44,45} Although easily accessible or economic adaptations have been described, many are still not practiced. This forces residents to perform and acquire experience directly from the patients with techniques such as “learning as they go” practicing their first procedures trans-operatively, without validating their knowledge or ability. This is not only unethical in today’s medical practice, but also dangerous. Residents should acquire a specific level of skill and knowledge before being allowed to practice on patients, and not only from visualizing surgeries repetitively as an aid.^{46,47}

ETHICAL CONCERNS

Patient safety concerns call for the need to train medical personnel in simulated settings to reduce cost and patient morbidity. Technological innovations had led to consistent improvement in learning outcomes, and already play a role in surgical training programs.⁴⁸

The ability to acquire surgical skills requires consistent practice, and evidence suggests that many of these technical skills can be learned away from the operating room.^{13,41} Simulation represents ideal teaching methods to optimize the knowledge and skill of residents before they are entrusted with procedures in real patients. However, which method is better? How can we confirm the skills are being properly learned and performed? Are they properly supervised? Can simulation replace the lack of exposure? Is consent needed from the patient to have a resident perform a procedure?

CONCLUSION

Using simulators in different surgical areas, for the training of novices or already expert surgeons is crucial for patient management and reducing the margin of error, surgery time, and providing confidence in the learner, perfecting the techniques and maneuvers. Thanks to technological advancements and innovation, there is a wide range of various types of simulators that can be used for surgical training. Training hospitals and universities should make simulation training mandatory in their curriculums, both for medical students and residents. Programs should have a formal structure, feedback, and be purposefully designed.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: Not required

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Cite this article as: Fernández-Reyes BA, Flores-González AK, Alvarez-Lozada LA, Guerrero-Zertuche JT, Arrambide-Garza FJ, Quiroz-Perales XG, et al. The importance of simulation training in surgical sciences. *Int Surg J* 2022;9:1289-93.