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Mini Review

Use of Simulation in the Teaching of Surgery

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Abstract

The traditional method of teaching surgical skill has been modified in recent years due to social and technological progress. The Willian S Halsted model has become obsolete and has been replaced by new learning systems, based on competencies that allow the apprentice to achieve the goals necessary for their complete training.

A simulator, which complements the experience with clinical patient care, has been established as an effective and necessary tool to achieve skills. Simulators offer personalized training, adapted to the needs of each user as well as allowing, among other advantages, to repeat different tasks indefinitely. Therefore, this generates a reduction in the number of hours in the operating room, increasing the safety of the trainees and reducing possible errors.

Laparoscopic surgery has been one of the techniques that have benefited the most from simulation as a method of teaching surgery. Box simulators, virtual reality, augmented reality, and animal models are seated as the most used models today in laparoscopic surgery and their use depends on the level of experience, price and the skills that need to be acquired.

Keywords: Simulation; Surgery; Training; Laparoscopy

Introduction

Simulation in the health field consists of reproducing an environment similar to reality, in which the professional can act according to certain situations, similar to the one they would face in clinical practice with patients.

Since the 18th century, surgical training has been based on the traditional mentor-apprentice model [1], developed in Germany by Bernhard von Langenbeck [2,3]. In the 19th century it was perfected by Willian Steward Halsted, considered responsible for the introduction of the first program of surgery residents. This fact was decisive for the generalization of the teaching of surgery, under the premise "see, do, teach" [2].

This model, implemented at the Johns Hopkins Hospital in Baltimore at the end of the 19th century [1], presented a methodology based on gradually assuming responsibilities by the professional in training, tutored by a surgeon with more experience and practicing the different procedures directly on the patient [4].

The traditional method of teaching surgery has advantages due to the direct exposure of the trainee to real situations. Instead, it has a number of drawbacks, as learning depends largely on the technical knowledge of the tutor and his or her ability as a teacher. In addition, not all professionals in training have the same speed when it comes to acquiring the necessary skills to master the different surgical procedures.

It is worth mentioning that exposing surgeons in training to perform complex procedures without having sufficient technical knowledge can generate a bad experience for them, together with the possible adverse consequences that their errors may generate on the patient [5].

With this method, the learning process takes place on the direct dealings with the patient [3]. Once the residency programs have been concluded, with duration of 4 to 5 years, the doctor is qualified as a specialist; however, the question arises as to whether, once these programs are completed, residents are able to acquire the necessary skills to work without supervision, which raises the modification of the traditional method [6].

Paradigm Shift

The social and technological changes of the last decades have generated the need to modify the training of surgeons. These present a limited time in their learning for the large number of knowledges they must acquire; Furthermore, the low incidence of certain pathologies makes it difficult to complete training for those who are in lower-level hospitals, to which is added a growing limitation of healthcare spending [4,5].

In this context, medical teaching has taken on a more experiential nature in content and methodology, trying to solve the challenges posed by the aforementioned new health reality [1]. This new teaching method is complemented with elements of the traditional model.

The need for an improvement in teaching caused pedagogical research to focus on competencies, which, together with the constructivist model based on experiential learning, try to ensure that the professional in training acquires the fundamental knowledge and is trained to apply it in a practice in real clinical situations [3].

In experience-based learning, the student goes through three stages: cognitive, integrative and autonomous. When residents are faced with a new task, they go through the cognitive stage to assimilate and understand the necessary steps. In the integration stage, there is

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an improvement in the apprentice, the movements being smoother and precise. Finally, in the autonomous stage, the performance of the activity is fluid and efficient, completely dominating the procedure studied [2].

Competency-Based Medical Education (CBME) emerged as a concept to ensure that learners, whether students or residents, are able to master the skills and knowledge necessary to perform certain pre-established tasks [6,7].

Faced with this search to improve teaching, simulation is established as a fundamental element that allows obtaining surgical knowledge and skills; also solving the increased need to obtain surgeons' competencies, 1 and thus rendering the Willian S Halsted model "see one, do one, teach one" obsolete [8,9].

Simulation

Simulation is the action of recreating something trying to imitate real situations. It comes from the Latin, «similis» (resemblance) and «ion» (action and effect). A simulator, therefore, is a tool that allows a simulation to be carried out.10 In medicine, simulation is defined as the performance of different procedures in a controlled environment, which serve as training for their subsequent application in clinical practice.

Military development, specifically the air forces, was a breakthrough in simulation. In 1929, Edwin A. Link presented a "Link Trainer" flight simulator, as a complementary model to the traditional training of pilots. In the 1960s, these training methods in medicine began to be incorporated, adapting to the continuous advances and needs of medical practice [5,10].

In 1964 the Declaration of Helsinki was established by the World Medical Association (WMA) [10]. This international document groups together ethical and regulatory principles for research on human beings after the creation, in 1947, of the Nüremberg Code.

At the beginning of the 20th century, the American College of Surgeons and the Accreditation Council for Graduate Medical Education accepted simulation as a basic training method and incorporated it into teaching programs, in which we emphasized laparoscopic surgery [10]. This fact represented a change in training of surgeons.

The simulation allows acquiring the necessary skills in surgery shortening the learning curve, in a controlled environment [5]. The term "Learning Curve" or "surgical learning curve" (LC) was introduced in surgery to refer to the number of interventions that should perform a surgeon to achieve a level of experience considered adequate while minimizing the number of complications. Depending on the type of surgery, between 15 and 100 repetitions of the different procedures are estimated to reach the plateau, and with this mastery of the technique, of the learning curve [11-13].

With the incorporation of minimally invasive techniques, which require specific skills as occurs in laparoscopic surgery, the need for the use of simulators is reaffirmed; that allow professionals to learn and improve their skills as surgeons in a safe environment and acquire the necessary skills to approach the operation in the best possible conditions [5,9].

Simulation, therefore, has been included as a method of teaching medicine, both for students and professionals, through the use of different clinical stays simulated by actors who interpret the patients, mannequins for the use of resuscitation, exploration and training of surgical procedures in wet (using animals or animal tissue), dry (based on different hardware for simulation, or mannequins) and cadaveric laboratories [5,9].

Objectives of the simulation

The surgical simulation aims to: [4,5,10]

1. Exposing the apprentice to situations for their proper professional development. Communication and team cooperation, decision-making and management of available resources are trained in the face of possible unforeseen events that may arise during practice.
2. Allow to apply the skills and techniques acquired in the training to shorten the learning curve and improve the final result of the trained procedures. The feedback generated by the simulation, whose characteristics were described by Hewson and Little, 4 together with the "Debriefing" (review of the actions taken in the exercises during the simulation), are a fundamental element in learning, according to education experts.
3. Reinforce the learning and management of low prevalence pathologies, which without simulated training would be almost impossible to acquire the necessary skills for their correct approach.
4. Develop flexible and individualized training programs that allow the levels of difficulty to be adjusted for the acquisition of the different competences as the user needs.
5. Standardize learning through objective and structured exams that allow overcoming general and pre-established competencies; o periodic evaluations to update the training of professionals.
6. Reduce errors with indefinite repetition of techniques so that they do not occur or are minimal in health practice.
7. Stimulate learning by obtaining achievements and overcoming stages for the acquisition of skills that will be incorporated into clinical practice.

Main simulation models

Simulation with corpses: Throughout history, the cadaveric model has been used for teaching anatomy and surgery, allowing the simulation of the entire operation; despite being dead tissue, pressurized systems have been used to perfuse the tissue and achieve greater fidelity. However, they are expensive, not reusable according to certain procedures and ethical restrictions in some countries have limited their use [6,14].

Mannequins: In 1960, Asmund Laerdal created the first life-size mannequin, called "Resusci Anneas," with the aim of teaching medical students how to perform the mouth-to-mouth maneuver, as a first aid measure [6].

In 1980, a mannequin prototype called the Comprehensive Anesthesia Simulation Environment (CASE) was marketed, which used software to simulate vital signs and allowed both technical and communication skills to be practiced on them. East fact led to the construction of the first medical simulation educational center, the

Boston Anesthesia Simulation Center [14].

This model has been advanced and perfected over time, simulating a whole body or parts of it, allowing learning to explore cavities, intubate or suture wounds; Furthermore, the use of dummies in vascular surgery, by using perfused models, allows tasks such as the repair of aortic aneurysms or a carotid endarterectomy to be carried out [6,14].

The use of manikins that simulate the human body is used as a teaching method in Advanced Cardiac Life Support (ACLS), a program sponsored by the American Heart Association and in the Advanced Trauma Life Support (ATLS) program sponsored by the American College of Surgeons [6].

Bench models: This model is the simplest and cheapest form of surgical simulation. It consists of a table, with synthetic material simulating human skin, to make sutures; a simple tool that allows you to practice and learn basic skills and concepts necessary for handling surgical instruments [14].

The bench model allows you to practice without the need for specific facilities and to increase the level of difficulty, by using finer sutures, such as Prolene 5.0, suturing Penrose drains or anastomosis on a graft with ePTFE sutures [6].

Simulation with people: This teaching model is very useful in interprofessional teams, in which real scenarios are simulated and the communication and reaction of the members is practiced in crisis situations, allowing them to respond more efficiently. It consists of videotaping an exercise and then reviewing it, allowing each team participant to analyze their actions and understand the aspects that need to be improved [6].

3D print: 3D models are three-dimensional structures that allow the simulation laboratory to know exactly the human anatomy and practice the steps to follow in a surgical procedure before operating in the operating room. This previous exercise manages to anticipate and solve possible complications that the surgery may have in addition to reducing the level of stress and increasing confidence among professionals.

They allow, for example, to reproduce the carotid anatomy, based on the patient's own CT angiography, for the subsequent implantation of a stent 6 or to construct training models for use in laparoscopic cage simulators or other minimally invasive surgeries [14].

Virtual reality simulators: In the 1990s, virtual reality was integrated into surgical education programs, given the evidence of the improvements it offers in training [14]. These simulators allow the user to improve their skills for different types of surgeries and have served as a basis for the development of teaching in robotic surgery [6,15].

These models allow carrying out programs with common learning metrics, which include the time to complete a task, the mistakes made and the economy of movements. These metrics provide an objective assessment of the competencies that are necessary for professionals in training and that have been shown to improve subsequent operative performance [14].

The increased power and graphic capabilities of computers make the new virtual reality simulators create more realistic environments and allow anatomical structures to be observed with greater detail and clarity. In addition, they contain a greater storage capacity that allows recreating operations for different pathologies.

For example, the "NeuroTouch VR" neurosurgery simulator allows the simulation of microdissections, tumor aspiration and hemostasis among others [6]. The Angio-Mentor teaches endovascular skills, from balloon angioplasty to complex procedures such as endovascular repair of an aortic aneurysm [14].

Most virtual reality simulators are designed to teach laparoscopic and endoscopic procedures, as their dependence on video monitoring makes them naturally suitable for the virtual reality platform [8]. New models of augmented reality are added to these, detailed below [16].

Robotic virtual reality simulator: Robotic surgery, together with its simulation as a learning model, consists of a monitor attached to a console that controls the robotic arms that are on the operating table [15].

The main curricula of robotic surgery are the Fundamentals of Robotic Surgery (FRS), the Fundamental Skills of Robotic Surgery (FSRS), the Canadian Basic Skills Training Curriculum (BSTC) and the Association curriculum. European Institute of Urology (ERUS). These programs consist of a theoretical and a practical part, in which they use simulation models, but it is worth mentioning that these courses are in different stages of validation [17].

Currently, the most relevant robotic simulation devices available on the market are: da Vinci Skills Simulator® (dVSS), Mimic dV-Trainer® (MdVT), Robotic Surgery Simulator® (RoSS) and SimSurgery Educational Platform® (SEP) [14,15,17].

According to the review provided by Mazzon G et al. [13] we observed how the studies by Kang et al with the Mimic dV-Trainer and Wiener et al. trained with the Da Vinci Surgical Skill Simulator provided an improvement in the learning curve requiring fewer repetitions to achieve the required surgical tasks.

Augmented Reality simulators: Augmented Reality (AR) is a technology that emerged in the 1990s in the United States and that has developed exponentially to date, being included in video games and even being available on simple mobile devices [16].

This technology uses a real environment and superimposes virtual elements. AR devices require a display, a position tracking system, and software that transforms and incorporates data. The display can take the form of a traditional monitor such as the ProMIS 16 simulator or a Head-Mounted Device (HMD) such as Microsoft Hololens (illustration 1) or Google Glass, the first HMD device to be marketed [18].

AR has proven to be useful in the surgical act, superimposing images of x-rays or prostheses, without taking your eyes off the patient or the monitor in the case of minimally invasive techniques. On the contrary, multiple studies conclude that HMDs can cause side effects such as nausea, headache, or dizziness. In addition, this model can generate a decrease in the surgeon's visual field, limiting their actions during the operation [18].

Simulation with animals: It is one of the most widely accepted teaching methods thanks to its great similarity to human surgery. As it is a real surgical environment, it allows practicing both the surgical skills involved in the operation and the prevention and management of possible complications; communication and teamwork [6,14].

The main drawbacks in the use of animals for teaching surgery are both ethical and economic to use.

References

1. Toledo Martínez E, Martín Parra JI, Magadán Álvarez C, López Useros A, Fernández Santiago R, Regaño Díez S, et al. Influence of previous experience on the benefits of laparoscopic surgical training based on simulation. Cir Esp (Engl Ed). 2019;97(6):314-9.

2. da Costa GOF, Rocha HAL, de Moura Júnior LG, Medeiros FDC. Taxonomy of educational objectives and learning theories in the training of laparoscopic surgical techniques in a simulation environment. Rev Col Bras Cir. 2018;45(5):e1954.

3. Porras-Hernández JD. Surgical teaching and learning. Inv Ed Med. 2016;5(20):261-7.

4. Ruiz-Gómez JL, Martín-Parra JI, González-Noriega M, Redondo-Figuero CG, Manuel- Palazuelos JC. Simulation as a surgical teaching model. Cir Esp (Engl Ed). 2018;96(1):12-7.

5. León Ferrufino F, Varas Cohen J, Buckel Schaffner E, Crovari Eulufi F, Pimentel Müller F, Martínez Castillo J, et al. Simulation in laparoscopic surgery. Cir Esp. 2015;93(1):4-11.

6. Lu J, Cuff RF, Mansour MA. Simulation in surgical education. Am J Surg. 2021;221(3):509-14.

7. Beyer-Berjot L, Berdah S, Hashimoto DA, Darzi A, Aggarwal R. A virtual reality training curriculum for laparoscopic colorectal surgery. J Surg Educ. 2016;73(6):932-41.

8. Alaker M, Wynn GR, Arulampalam T. Virtual reality training in laparoscopic surgery: a systematic review & meta-analysis. Int J Surg. 2016;29:85-94.

9. Theodoulou I, Nicolaides M, Athanasiou T, Papalois A, Sideris M. Simulation-based learning strategies to teach undergraduate students basic surgical skills: a systematic review. J Surg Educ. 2018;75(5):1374-88.

10. Centella T, Hornero F. Simulation-based training: a necessary change in the training of our specialty. Cir Cardiov. 2017;24(4):187-9.

11. Guerrero-Hernández AJ, Palacios-Zertuche JT, Reyna-Sepúlveda FJ, Muñoz-Maldonado GE. Laparoscopic training by use of a physical simulator and its application in the general surgery residency. Med Univ. 2016;18(73):189-93.

12. Leijte E, de Blaauw I, Van Workum F, Rosman C, Botden S. Robot assisted versus laparoscopic suturing learning curve in a simulated setting. Surg Endosc. 2020;34(8):3679-89.

13. Mazzon G, Sridhar A, Busuttil G, Thompson J, Nathan S, Briggs T, et al. Learning curves for robotic surgery: a review of the recent literature. Curr Urol Rep. 2017;18(11):89.

14. Badash I, Burtt K, Solorzano CA, Carey JN. Innovations in surgery simulation: a review of past, current and future techniques. Ann Transl Med. 2016;4(23):453.

15. Bresler L, Perez M, Hubert J, Henry JP, Perrenot C. Residency training in robotic surgery: The role of simulation. J Visc Surg. 2020;157(3 Suppl 2):S123-9.

16. Barsom EZ, Graafland M, Schijven MP. Systematic review on the effectiveness of augmented reality applications in medical training. Surg Endosc. 2016;30(10):4174-83.

17. Nezhat C, Lakhi N. Learning experiences in robotic-assisted laparoscopic surgery. Best Pract Res Clin Obstet Gynaecol. 2016;35:20-9.

18. McKnight RR, Pean CA, Buck JS, Hwang JS, Hsu JR, Pierrie SN. Virtual reality and augmented reality-translating surgical training into surgical technique. Curr Rev Musculoskelet Med. 2020;13(6):663-74.