ARTIGO

Simulation in Medical Education

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INTRODUCTION

For nearly 100 years the simulation is used for learning. It is unthinkable to an airline pilot making his first flight in command of an aircraft without first having spent many hours practicing on a simulator. We, the passengers, travel only on aircraft that are controlled by pilots who repeated as often as necessary, their work routines, until they reached a great run, and then be considered fit to carry on.

Astronauts come and go many times to the moon, dentists fix complicated teeth, managers of oil platforms faithfully reproduce the headquarters of his business the rooms of his subordinates on the high seas, to discuss critical issues on the same level of perception and stress of the situation, an immersion provided by simulation.

In other cases it is the reality that follows the simulation, as in the example of the designers and architects who have offered to its customers through a "virtual tour" for the future house, allowing the perception of space dimensions, materials, colors and lighting.

Medical education began using mannequins and gathering technologies since 1950, teaching methodologies were developed based on problems of practical life of the physician, thus generating a new perspective on teaching: a simulation in medicine.

The traditional model of medical education is evolving from a teacher centered, didactic driven model, toward an integrated multidisciplinary and interprofessional learning experience. This paradigm shift reflects the need to fill the gap between the traditional role of a comprehensive medical education and the focused patient care realities necessary in the clinical environment.

During medical education the apprentice physician is challenged in several ways. First, the very learning experience that the student relies on is highly dependent on the exposure to a specific case occurring during his or her time on service. Second, there is an ever increasing demand for time efficiency. The days of a student spending long periods of time with a patient in clinic are necessarily gone. Thirdly, there are societal pressures that demand increased patient safety and cost reduction in health care.

This background creates the perfect environment for simulation development in medical training. Through simulation, medical trainees can learn both basic and complex concepts as well as develop essential technical skills prior to patient exposure. The insertion of this new step in training, facilitates a uniform learning experience such that even rare conditions can be re-created in a controlled environment. The widespread implementation of simulation activities will hopefully improve the quality of care and increase patient safety.

The objective of this chapter is to approach the rationale and the models of simulation in the medical education.

RATIONALE FOR MEDICAL SIMULATION:

In the first phase of medical education, the preclinical phase, there is an emphasis on developing a broad base of medical knowledge. The trainee is expected to learn the normal structure, function and physiology of the human body as well as the pathophysiology of the most prevalent diseases. A gap can be observed between the traditional teaching model, where the student is fed a description of signs and symptoms, and the clinical environment, where the student must extract the information then recognize and interpret the signs and symptoms presented by the patient.

In the second phase, the clinical phase, the trainee is exposed to real cases, with the objective to translate and synthesize the theoretical knowledge into practice. An emphasis on history collection and physical examination is common in this phase as well as an introduction to therapeutic planning. Because of the increasing societal pressures for efficiency and less tolerance for "learning on patients", the traditional apprenticeship found in this phase of education offers less autonomy and fewer opportunities to practice techniques and procedures. As a consequence graduating medical students arrive at their internships less prepared to perform basic skills necessary to be effective on day one.

In the third phase of medical education, the residency, the objective is to provide focused training based on clinical practice. Responsibility for the patient is increased progressively in each year of training. The main goal is that the physician becomes a specialist in one field of medicine by developing their skills in a protected and supervised environment, until they achieve the capacity to practice independently.

The medical residency is based on the "Halstedian Model", where the novice is tutored by a more experienced attending physician. The transference of information from teacher to student depends heavily on the patients arriving in a given period of time. As a consequence an inconsistent physician product may occur at the end of this apprenticeship. This variability is further compounded by the modern trends of shorter hospitalizations, briefer clinic visits, and tighter work hour restrictions which limit the interaction between the trainees and the patients.

After residency formal medical education ends abruptly. In this phase there are limited opportunities for learning new techniques or re-training. The physician starts a career in which he or she is responsible for developing his or her own education while simultaneously managing other professional duties.

All of these factors occurring within the context of a treacherous medico-legal environment create an ideal environment to utilize simulation activities as it fosters a protected learning environment for the acquisition of new skills as well as cognitive rehearsal for a multitude of clinical scenarios in an intensive and uniform fashion.

MOTOR LEARNING THEORIES: THE BASICS

Fitts and Postner defined a three stage process for manual skill acquisition: a cognitive stage, an associative stage, and an autonomous stage (1). In the cognitive stage the trainee is exposed to the theoretical knowledge of the task. After getting the basic understanding of the procedure, he can advance to the associative stage, where he will translate the theoretical knowledge into action, through a controlled pattern of movements. Finally, after a period of practice, the initial rough movements become more precise and automated, demanding less attention from the operator. The progression through these phases should serve as the basis for the development and evaluation of a structured learning curriculum.

DEFINITION AND GOALS OF MEDICAL SIMULATION:

Simulation can be defined as a technique to replace or amplify real experiences with guided experiences, often immersive in nature, that evoke or replicate substantial aspects of the real world in a fully interactive fashion (2).

The ultimate goal of medical simulation is to improve the quality of care delivered and increase patient safety. To achieve this goal, benchmarks of success must be established and a validated training method to reach them must be developed. Regardless of the design of a curriculum it is of paramount importance to define the standards and the learning objectives for the activity. This curriculum should allow for deliberate practice, establish a progressive increase in task complexity, and offer routine debriefing and feedback for the trainees.

Deliberate practice refers to a repetitive and focused practice, associated with a monitoring of performance that allows immediate correction of the tasks. In other words, free access to the simulator and the availability of an expert to feedback the trainee about his performance (3).

In most cases repetition is the key to attaining automaticity. How much repetition is required is where the greatest challenge exists among a cohort with a wide range of skills. Curricula based on reaching proficiency benchmarks offer the most flexibility and efficiency of resource utilization.

A proficiency based curriculum, instead of a curriculum based on practice time or number of repetitions, takes pre-procedural skill level or aptitude into consideration while still making sure that at the end of training, all trainees reach a pre-determined target level. After a set number of guided instructional periods an individual spends as much or as little time as necessary in deliberate practice to reach the established benchmark.

In addition, a progressive or "spiral curricula" in which task difficulty or simulation complexity is increased over time has been demonstrated to enhance the trainee's learning (4).

The importance of feedback in learning has been well demonstrated in medical simulation and facilitates a greater understanding by the trainee through the learning process (5). However the amount of feedback required is still not clearly understood. In a well designed trial, groups were divided according to the feedback intensity. One group had frequent and intense extrinsic feedback, during 100% of training time. A second group had the extrinsic feedback restricted to a total time of no more than 10 min in each hour session. A third group had a restricted extrinsic feedback (less than 10 min in each hour session) associated with video tutoring during every training session. The groups with limited external feedback had a faster learning curve measured by the number of repetitions to achieve proficiency, than the intense feedback group (6). It is hypothesized that the understanding gained through overcoming struggles independently may be more beneficial than immediate intensive correction which may prevent the learner from recognizing key performance elements.

CLASSIFICATION OF SIMULATORS AND SIMULATIONS:

Different types of simulators are available and used in medical education. These can be roughly grouped into: bench models, live animals, cadavers, human performance simulators and virtual reality surgical simulators (7).

Bench models are inanimate teaching aids that are usually cheap, portable and often reusable. They provide a great cost benefit with minimal risks associated with their use. Their strength is in the ability to allow the deconstruction of complicated tasks into their essential elements. They function well to teach novice learners basic skill tasks. Their limitation is the low fidelity offered that restricts their ability to simulate complex procedures.

Live animals animal provide high fidelity simulation of complex tasks such as operations in "real life" conditions. They are best used to simulate living tissue behavior and test advanced skills where technical considerations effect outcome such as laparoscopic intracorporeal suturing, hemostasis, etc. The high costs, need for specialized facilities and personnel, ethical concerns, anatomical differences, and lack of reuse limit the widespread use of this type of model.

Cadavers have the highest anatomic fidelity and allow for complex procedure or operation simulation. They are best utilized to teach specific procedural knowledge and dissection skills. The cost, availability, infection risk and ethical factors limit its broad application.

Human performance simulators can be used repeatedly with high fidelity and permit interactivity. Mannequins with various levels of sophistication can be used in single specialty multidisciplinary or interprofessional scenarios for team training and crisis resource management. The main limitations are the costs and the limited technical application (not a skill acquired, but a response pattern).

Virtual reality surgical simulators have the advantage of being reusable, can capture and store data metrics to provide performance feedback and have minimal setup time. They can be used for basic and advanced laparoscopic, thoracoscopic, bronchoscopic and endoscopic skills. The main limitations are the costs, maintenance, and limited haptic feedback.

CHOOSING THE BEST TOOL

The simulation can be used during any moment of medical training: 1) during the basic sciences module, with the use of body, bench models and software for 3D anatomy, while the physiology and pharmacology benefit from the demonstration of high-fidelity mannequins; 2) as a method for teaching interview techniques with the development of communication skills by recording the interview process with live models dramatization (role-playing) followed by interactive feedback with the analysis of the recording (8). This technique is especially interesting to teach students how to communicate bad news (9); 3) during the semiology module, with the use of simulation for physical examination practice of; the ability conducting medical and surgical procedures can be developed in simple dummies (low fidelity) (10); 4) at any point of the medical professional life scenarios with high fidelity mannequins and actors allows the experience of complex and critical situations.

Simulation is also an effective tool in the assessment of acquired skills and medical knowledge, to evaluate the development of professionalism, teamwork, interpersonal skills, decision making and prioritization of tasks.

RESULTS OF SIMULATION TRAINING:

Following this broad review of simulation in medical training, the main issue raised is whether there is an impact of this practice on health care.

It has been demonstrated in different specialties that the clinical skill acquired during simulation can be transferred to clinical practice. Surgical residents who practice to technical proficiency in a fascia closure model had a better performance in the operating room than those who didn't, as measured by an Objective Structured Assessment of Technical Skills (OSATS) global rating scale (11). In addition, residents trained on the model had a better cognitive performance than those who didn't train, suggesting that acquisition of a basic skill in the simulation lab allows a better focus on other cognitive issues involved in a real surgery (12). Interestingly, trainees that achieve task automaticity have a better skill transfer than those who train to proficiency (13). In another example, residents trained to place peripherally inserted central catheters did better when trained under simulation than those trained by apprenticeship methods, demonstrating skills transfer from the lab to clinical practice (14). Level I data is available for different medical specialties, from colonoscopic performance to urologic procedures (15,16). It is important to realize that knowledge acquisition is not restricted to technical skills. Students trained in a simulator to identify an aortic murmur performed better in the identification of this sign in actual patients than their traditionally trained peers (17). A recent qualitative review of the literature suggested benefits of simulation in patient and public health (18). In a 900 bed tertiary-care urban teaching hospital, a cost analysis of simulation training in central vein catheter insertion, it was demonstrated that a reduction of catheter-related blood stream infections can result in an annual cost savings of greater than 700,000 dollars. With the training cost estimated at around 112,000 dollars, a 7 to 1 rate of return on the simulation could be observed (19).

VIRTUOHSU CASE STUDY:

Oregon Health & Science University (OHSU) is located in Portland, Oregon and is the second oldest medical school west of the Mississippi River, with a charter date of 1887. It is the only medical school in the state and is responsible for the education of 705 residents annually. OHSU hosts the only surgical training program in the state and is accredited to graduate twelve chief residents every year. The OHSU surgery residency is the second largest in the country. VirtuOHSU is the designated name for the comprehensive OHSU Surgical Simulation Program, which engages learners and faculty from across the entire campus. Users include the Departments of Anesthesiology (Accredited Simulation program by the ASA), Obstetrics and Gynecology, Neurosurgery, Critical Care, Orthopedics, Internal Medicine, Pulmonary Medicine, Emergency Medicine, nursing and Hospital Administration . VirtuOHSU was accredited by the American College of Surgeons as a Level I Comprehensive Educational Institute in 2009.

Training in minimally invasive surgery has had a long and rich tradition at OHSU dating back to 1992 when a small room was allocated for deliberate practice. The purpose of that space was to provide laparoscopic training facilities for the surgery residents to be able to practice their skills during down time or waiting for case turnover. Recognizing the obstacles to residents utilizing training facilities without a formal educational plan, a formal Laparoscopic Training Program was initiated in January, 2005 within the OHSU Department of Surgery. This program was directed towards all first and second year surgery residents and consisted of eight hours of hands-on training over a month's period of time. A syllabus of collected manuscripts addressing topics in the curriculum was provided to the residents. Additionally, a collaborative relationship was established with the Legacy Simulation Program where on a semi-annual basis, surgery residents attended a basic laparoscopy course at Legacy.

In 2007, Dr. Donn Spight was named as the Medical Director for Surgical Simulation Education. Dr. Spight embarked on a vigorous program to enhance simulation training for the residents. Ultrasound and vascular skills training were added to the existing curriculum. In 2008, a bold expansion of the existing Monday morning educational program enabled open, endoscopic, and communication skills training to be added to the curriculum. This change removed all categorical and preliminary post graduate year surgery residents from clinical duties for five hours every Monday, representing significant investment to education by the Department.

While the Department of Surgery expanded its educational curriculum, multi-disciplinary collaborative efforts within OHSU leadership led to the creation of a robust simulation network. This network was designed to breakdown existing silos of simulation training throughout the campus. As simulation efforts rapidly expanded, the Department of Surgery Executive Education Committee recognized that the existing space in University Hospital no longer met the training needs of the residents. In 2008 $205,000 was invested to remodel a 1500 square feet room located in the Old Library building providing a much larger simulation space.

VirtuOHSU has access to three conference rooms in the Old Library with a combined 2000 square feet of meeting space. These conference rooms can be scheduled to accommodate didactic presentations or debriefings. Video conferencing is available in the same building in the auditorium which has over 4000 square feet of space. Within a distributive model of simulation training at OHSU, there are two other sites that are accessed by all members of the VirtuOHSU network as needed. These include simulated clinic space used for standardized patient exercises and a 7000 square foot facility used for team based simulation exercises and Crew Resource Management (CRM). The VirtuOHSU website http://www.ohsu.edu/xd/education/simulation-at-ohsu/programs/virtu-ohsu/index.cfm was launched in 2010 and serves to coordinate and catalog activities within the center.

The leadership of VirtuOHSU is headed by Dr. John Hunter, Mackenzie Professor and Chair of Surgery. During the ten years that Dr. Hunter has been at OHSU, he has set an aggressive agenda to have simulation training as one of the key priorities of the Department and the Institution. Various leadership positions exist within VirtuOHSU. There is an Education Director, Medical Director, Administrative Director and Program Director each of whom share responsibility for the offerings of the skills center. Content oriented tasks include curriculum development and validation for simulation programs including expansion of practice, interdisciplinary training, introduction of new skills, maintenance of skills, long term follow-up of the learner, remediation of practice and research. Logistics and administrative tasks include data management, maintenance of accreditation, scheduling of activities, managing industry relationships, fundraising, accounting and budgetary functions, document preparation, equipment acquisition, equipment maintenance, ordering supplies and running labs.

Many of the Department of Surgery faculty members are instructors for VirtuOHSU. Faculty members from the departments of Anesthesia, Emergency Medicine, Obstetrics and Gynecology, Neonatology and Nursing also serve a critical role within the VirtuOHSU network.

The primary goal of VirtuOHSU is to provide a controlled setting for simulation of technical skills and team training. Learners include medical students, residents, physicians in practice, physicians seeking re-entry into the work force or needing remediation, nursing and other healthcare providers. VirtuOHSU provides educational resources for other institutional entities in simulation curriculum development and implementation. VirtuOHSU also actively participates in healthcare pipeline activities that are critical to the state of Oregon. Undergraduate and high school students are exposed to surgical career opportunities through partnerships with many grass roots organizations.

The strength of the VirtuOHSU network comes from many sources, including the skill level of the faculty who are involved in teaching, the strong desire from multiple departments to participate, a collaborative relationship with hospital based nursing, the support of the President and Provost of the University and the financial support from donors in the community who are committed to the success of VirtuOHSU. Another major strength comes from our participation in the Northwest Simulation Alliance which includes OHSU, University of Washington and the University of British Columbia.

Since accreditation by the American College of Surgeons in 2009 VirtuOHSU has seen a dramatic expansion in the depth and breadth of offerings to a variety of users. Industry grant, in-kind and philanthropic support has surpassed 1 million dollars. The utilization of the skills lab has increased almost 50 % in the last 3 academic calendar years. 10,000 simulation user visits have generated 1100 hours of lab use. The impact that the presence of a robust simulation program has on resident satisfaction and recruitment is evident on departmental surveys, the dramatic increase in medical students choosing surgery as a career and the caliber of residency applicants.

VirtuOHSU has been instrumental in developing and implementing standardized training for Central Venous Catheter (CVC) insertion and Robotic surgery across multiple disciplines. The interdisciplinary and interprofessional collaboration required to bring these institutional objectives to fruition has provided significant visibility and represent a substantial maturation of the program.

A particularly successful VirtuOHSU activity has been a partnership with the Legacy Institute for Surgical Education and Innovation another American College of Surgeons accredited educational institute. The purpose of this partnership is to utilize cadaveric and porcine models to perform index operations as outlined by the American College of Surgeons/Association for Program Directors in Surgery (ACS/APDS) Phase II curriculum (20)and a novel vascular surgery curriculum. The use of these models in simulated operating room conditions affords cognitive and technical procedural mastery not possible in low fidelity simulation environments. Prior to experiences of this type the only opportunity for our trainees to appreciate advanced surgical anatomy, benefit from preceptor technical experience or learn proper use of specialty devices was in the operating room on actual patients. Five lab sessions per year have been held since 2010 with fantastic reviews. In 2011 the length of the lab sessions was expanded to allow members of the Cardiothoracic and Plastic surgery divisions to utilize the remaining tissues for their respective learners. The Vascular experience in this activity was presented at the ACS AEI (American College of Surgeons Accredited Education Institutes) meeting in 2010 in Toronto, Canada. We are confident that these types of training activities have a positive effect on resident operative confidence and performance in the operating room. It is our hope that this educational effort will translate to into the ultimate goal of greater patient safety.

CHALLENGES

The challenges faced by our center are similar to many others attempting to implement simulation widely. Faculty participation, financial resources and space are paramount to sustainability of a robust simulation program. Recruitment of willing and able faculty members has been assisted by new hires and a recently codified educational track by the university promotions and tenure committee. Additionally, the acquisition of a full time Program Director and three undergraduate volunteers has eased the extraneous burden on faculty participation by facilitating scheduling and course logistics. Currently there are 8 faculty members considered as core surgical simulation teaching staff in VirtuOHSU up from 6 in 2009 which was up from 1 in 2007. An effort to involve more community surgeons is ongoing.

SUPPORT

The support for VirtuOHSU from the University and the Department has been significant. The University provides approximately 1500 square feet of dedicated space for the surgical and procedure skills laboratory. Overhead costs associated with occupying the current space continue to be supported by the OHSU hospital and the School of Medicine. VirtuOHSU receives financial and in-kind supply support from many industry sources. For the past 6 years, the Department of Surgery has hosted a golf tournament / auction where all net proceeds were dedicated to the simulation center. Several of the participants are grateful patients who want to have a long-term relationship with the Department of Surgery and enjoy supporting this fundraising effort. The Department of Surgery has netted close to $700,000 from these events. Proceeds from the golf tournament have allowed the purchase of two Virtual Reality simulators, supported faculty salary and provided necessary equipment. An additional benefit from the charity event is that over one hundred referrals to OHSU have occurred from participants in the golf tournament. This is a particularly compelling point for consideration by the University when looking at commitments made towards simulation education.

We are very optimistic about the future of VirtuOHSU. As simulation facilities expand on campus the opportunity for interdisciplinary and interprofessional collaboration will be tremendous at all levels. As the medical school prepares for its next Liaison Committee on Medical Education (LCME) accreditation process simulation will play a larger role than ever in a new curriculum. Crisis Resource Management (CRM) training supported by the hospital around critical intensive care unit safety issues is being developed for the entire team. In the next academic year significant expansions in the laparoscopy, vascular and cardio-thoracic courses will occur. Beyond trainees, our hope is that in the next three years the emerging successes in the development of curricula for CVC training, Robotic surgery training and laparoscopic common bile duct exploration training can be turned into Continuing Medical Education (CME) type activities for members of the community.

LOCAL PERSPECTIVE – RIO DE JANEIRO / BRAZIL.

The use of simulation technology in education is increasing and irreversible. This technique does not intend to replace other methods of learning, but to leverage the teaching of medicine. In May 2011, simulation skills lab become a quality indicator for medicine courses in Brazil, instrument proposed by the Ministry of Education - SINAES (21).

SIMULATION LABORATORY UERJ

At first UERJ is establishing national and international partnerships in this field. The aims are the introduction of this technique in their health science courses, and the construction of a multidisciplinary Simulation Laboratory. Multidisciplinary integration has already started with the telehealth laboratory. Altogether, research development on teaching methods , innovation in the processes of care (access, care, diagnosis, treatment and monitoring) built by working in different areas of knowledge (medicine, nursing, dentistry, nutrition, psychology, engineering, information technology, management, design, among others), and stimulus for training health care teachers through continuing education in this laboratory are under the scope of this project.

The insertion of this learning process occurs in a horizontal manner, through the entire curriculum. The trajectory of learning skills in medicine can be understood as a succession of stages in which the seizure and development of knowledge, skills and attitudes required, will occur gradually, over a gradient of increasing accuracy and autonomy (22).

CONCLUSION

It is clear that the model for medical education is changing from a teacher centered, apprenticeship model to one that incorporates the use of multi-modality, multidisciplinary and interprofessional simulation. Multiple studies have shown that when implemented correctly simulation curricula can lead to improved student confidence, clinical skills, OR performance, teamwork and efficiency. When one considers that the length of medical education throughout the entire continuum has remained stagnant despite the tremendous growth in knowledge and technology over the last century, it is clear that the traditional training paradigm is no longer adequate. Limitations in work hours combined with medico-legal, financial efficiency and societal pressures to improve patient safety provide the perfect framework for the widespread adoption of simulation.

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