RESEARCH

Medical Simulation: A Growing Medical Teaching Method and Field of Research

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WHAT IS MEDICAL SIMULATION?

Medical Simulation is a type of training where a controlled environment is created for the learner to practice tasks using high tech robotic models, low tech models or computerized virtual reality. Various feedback methods can be used to help the learners improve their skills, including instructors, peers, actor-patients and video cameras. Simulation provides a valuable way for medical professionals to maintain and improve skills in league with other sophisticated training fields such as aviation, maritime and nuclear energy. The most important element of this training is the ability of the learner to review and perform procedures as often as necessary to reach proficiency without harming a patient.

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Journal of Hospital Librarianship, Vol. 7(4) 2007
Available online at http://jhspl.haworthpress.com

doi:10.1300/J186v07n04_07

There are typically three forms of simulation in medicine:

- High Fidelity–High Technology
  This form consists of a robotic mannequin that simulates many different human conditions and allows the instructor to create scenarios that test the learner's skill set. An instructor can make a Sim Man "crash" before the student's eyes making the feelings of intense pressure to perform come about and hopefully help the students to deal with that pressure before they work on a live human.

- Task Trainer Model–Low Technology
  This is comprised of many smaller models of body-specific systems on which a student can perform a specific procedure such as inserting a chest tube or drawing blood.

- Virtual Reality
  This is a computer program projecting an image of the procedure. The student uses joysticks and other tools as if they are performing on a person. Laparoscopic and othroscopic procedures are examples as well as endoscopy.

In addition to the above, injury simulation is also used in medical simulation. This is a type of makeup "special effects" in which makeup or rubber appliances are added to an actor-patient or a mannequin model to give realism for an injury or disease state. The main concept is that if a healthcare worker sees a realistic looking injury or disease state enough times they will be able to concentrate on the tasks needed for treatment rather than being distracted by the appearance or manner of the patient they are helping. According to Steven Dawson of Massachusetts General Hospital, "In a simulator, mistakes have no consequence other than to serve as markers of achievement: as a physician or other medical caregiver learns a procedure, errors should diminish and skill should improve" (1).

Many techniques have been developed that give a medical student the full experience of helping a person in need. For example, the simulation experience often requires the learner to fully immerse themselves into the situation they have been given. Thus, the environment will be equipped to appear real, such as a hospital surgery room, a car accident scene, or a disaster drill. It is most important that the learner be able to practice a real reaction to a simulated experience.

HISTORY OF MEDICAL SIMULATION

Medical simulation takes its roots from aeronautics and flight simulation. Military flight simulators helped establish the use of simulation as a cost-effective teaching methodology. The military makes heavy use of mandatory simulator training prior to actual flights. In the medical realm, anesthesiology was the first discipline to implement the use of new technology in training members to help reduce medical errors (2).

Resusci® Anne is used for CPR training and marks the beginning of the development of mannequins for medical training. Asmund Laerdal was the creator. At the time, he was a successful plastic toy manufacturer. In the early 1960s he was encouraged by Dr. Bjorn Lind and other Norwegian anesthesiologists to create a mannequin that would work well in demonstrating mouth to mouth resuscitation. This successful leap into simulation eventually led to The Laerdal company creation of Sim Man® a high fidelity mannequin capable of simulating many disease and trauma states in the 1990s.

In the mid-1960s, Dr. Stephen Abrahamson, an engineer, and Dr Judson Denson, a physician created Sim One, the starting point of the computer controlled mannequin simulators. The initial idea of replicating anesthesia machine functions quickly evolved into the objective of recreating an entire patient for practice.

The Harvey cardiology mannequin was developed and first demonstrated by Dr. Michael Gordon in 1968. Harvey is the first example of the modern concept of a part task trainer for medical training. Simulating a spectrum of cardiac disease, Harvey can demonstrate variations in blood pressure, breathing, pulses, and normal heart sounds and murmurs. Through the present day, the Harvey mannequin has been an inspiration in the development of more portable and smaller cardiology patient simulators.

Computer-based anesthesia models were also developed to support anesthesia residents in managing intraoperative events. In the late 1980s, Dr. Howard Schwid further developed the concept of a screen-based simulation by simplifying the models to run on a desktop computer helping to reach a wider audience (3).

Today hundreds of medical simulation centers are running across the United States as well as world-wide. “Many experts believe that high fidelity simulation and virtual reality training will indeed prove to be ethically, financially and educationally more sound than live patient training. There is ongoing research addressing this very issue” (2).

EXAMPLES OF RESEARCH IN THE MEDICAL SIMULATION FIELD

Much of the research conducted in the arena of medical simulation has involved assessing the effectiveness of using this teaching model for the improvement of skills. Some research has also addressed cost-effectiveness of using medical simulation. A wide array of disciplines and skill-sets have been researched, including airway management, laparoscopic surgeries, endovascular surgery, suturing, advanced cardiac life support (ACLS), lavage, ultrasound, colonoscopy, and even endoscopic sinus surgery. Indeed, the teaching technique has become so well accepted in the surgery specialty that the Food and Drug Administration has recently begun requiring the completion of simulation training for physicians learning to perform carotid stenting (4).

Some specific, recent studies using medical simulation include a 2007 article in *Pediatric Emergency Care* entitled "High-fidelity medical simulation as an assessment tool for pediatric residents' airway management skills." The study observed 16 pediatric residents in two different computer-driven scenarios and asked them to manage the cases. The results of the study found considerable need for skill improvement and suggested that the training method was valuable in assessing the residents' ability to manage an airway without placing patient lives in danger (5).

Another, more qualitative study, by Wright and colleagues entitled "High fidelity medical simulation in the difficult environment of a helicopter: feasibility, self-efficacy and cost" was published in 2006. The study looked at the use of the Laedal SimMan (tm) in an EMS helicopter while running a flight and practicing cardiac and trauma cases. The residents were then surveyed about self-assessed comfort and if they perceived the exercises with the SimMan as valuable. The researchers concluded that providing a high fidelity medical experience in an air ambulance helicopter was feasible. However, they also found that the benefits of the technology must be weighed against the cost for each individual institution (6).

This sampling of recent studies out of the hundreds being performed across the globe endeavor to prove that simulated medical environments improve healthcare workers' skills when they are able to perform tasks in a risk free circumstance.

CONFERENCES AND ORGANIZATIONS DEVOTED TO MEDICAL SIMULATION

Society For Simulation In Health Care (SSH)

One measure of how prevalent medical simulation is becoming as a mode of teaching and learning is the growth of a new society, the Society for Simulation in Healthcare (SSH). It was established in January 2004 to represent the rapidly growing group of educators and researchers who utilize a variety of simulation techniques for education, testing, and research in health care. The membership, now over 1,500, is united by its desire to improve performance and reduce errors in patient care using all types of simulation including task trainers, human patient simulators, virtual reality, and standardized patients.

7th International Meeting on Simulation in Healthcare

The 7th annual medical simulation conference met Jan. 14-17, 2007 in Lake Buena Vista, Fl. The number of attendees was estimated at 1000, up from 600 attendees in 2006. The program committee was formed from an international group of medical professionals who drew upon their collectively diverse backgrounds to help plan a conference that captured the field and future of medical simulation.

The committee was well aware that most people perceive simulation as an education tool that uses computerized robots. Although that is partially true, they strived to provide content that would expand on that preconception showing the field offers so much more. Patient safety was emphasized as the central theme of the conference. Process improvement, modeling for disease states, and response and intervention for patient care were all goals for the conference proceedings.

Full scale high fidelity models are becoming more common, but there are many other tools and practices that are used to help medical personnel train to better serve the public. This conference made sure to include experts from the standardized patient realm and from video gaming technology to help encourage a collaboration of ideas that could move the field of medical simulation into new creative directions.

During the conference three information tracks were offered to help facilitate the best use of attendees' time:

- Simulation Operations Track, offering a series of sessions focused on basic needs of operating a SIM center;

- Nursing Track offered a series a sessions of nursing issues and how to use simulation; and
- Main Conference Track offered everything else for general attendees.

The conference provided workshops offering hands-on practice or demos of simulation technologies or practices. There were also panel discussions intended to focus on defining a scope of practice. Moderated roundtable discussions offered the opportunity to discuss an area of controversy or lack of data with other professionals as well as a chance to offer up suggestions and comments on various topics.

Abstracts and posters were displayed and considered the core of medical simulation's future by pushing the boundaries of what can be done in the field. The posters were presented by their authors and awards were given for the best projects. There were actually two abstract sessions, one peer reviewed and judged and the other called "Late Breaking Projects" allowed investigators to report their work, seek advice and generate interest in an ongoing project. The conference also offered an Expo floor giving the opportunity to see what vendors have to offer in the world of medical simulation.

Advanced Initiatives In Medical Simulation (AIMS)

The United States government has created a group to help promote the importance of medical simulation to the general public. The purpose is to make sure that the public knows about simulation research and practice and its impact on their future. Advanced Initiatives in Medical Simulation or AIMS is a coalition of individuals and organizations committed to promoting medical simulation as a way to:

- Improve patient safety
- Reduce medical errors
- Ensure provider competency
- Train people to respond to public emergencies and combat situations
- Reduce health care costs

These efforts will be achieved through:

- Engaging, energizing, and further developing the medical simulation community

- Articulating a clear community-wide message on simulation
- Fostering champions for medical simulation
- Creating awareness and educating about simulation
- Securing resources to further medical simulation training, research, and the deployment of simulators and simulation tools of all types

CONCLUSION

What is the future of medical simulation? Any prediction at this point could come true. The only limit is human imagination. Dawson speculates "We must demonstrate that the training acquired through simulation transfers to patient care. When this is accomplished, our educational curricula will be rewritten to incorporate simulation as a stand-in for actual patient contact during early learning, when physicians are at greatest risk for committing an error" (1).

The ongoing research that is proving the feasibility of this type of training will help to cement the concept that task training and practice without risk of causing harm to patients is the best possible scenario for all involved.

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doi:10.1300/J186v07n04_07