Simulation Training in Medical Education - An Opportunity for Biocommunicators

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Simulation training is rapidly moving to the forefront of healthcare, with particular interest in its application to patient safety and personnel competency. Technology today can create training simulations that replicate an extensive range of anatomical and physiological characteristics of the human body. The arena of simulation training draws on a wide array of individuals to achieve its purpose, and the biocommunicator with a vision to the future may be able to take advantage of the opportunities available.

Introduction

"When some of us first started our mannequin-based simulation work in the mid- to late 1980s, we believed that simulation would become important to healthcare over the following decade. Now as we are into our third decade of simulation work, we realized that we are still in the early phases of the decades-long process of embedding simulation into the fabric of healthcare. A number of observers – mostly those with a technological or entrepreneurial bent – have asked: 'What is the next big *invention* in simulation?' With a broader view they might ask: 'What is the next big *step* for simulation?' We would contend that while there is abundant need for technology development to make simulation devices of greater veracity and for more applications, the biggest step for simulation going forward will not be technological, but will be organizational. That is, even with today's technologies there is an enormous amount that can be accomplished with simulation that is not being done because the institutional mechanisms for providing it are immature." - Dr. David Gaba, Dept of Anesthesia, Stanford University School of Medicine (Gaba 2007).

With that opening commentary, suffice it to say that simulation training is a rapidly growing component in healthcare organizations. Training facilities can be housed at a university medical campus, public sector hospital, or conducted as a private company in support of several healthcare facilities. The use of high-technology mannequins capable of replicating thousands of physiological responses requires skilled technicians to program and operate them. Products referred to as low-technology simulators enable self-guided training in basic performance skills such as laparoscopic and endoscopic techniques, but still require skilled simulation specialists to maintain and educate and train others in the proper use of the equipment. Experienced individuals with backgrounds in nursing, computer science, healthcare sciences, video production, education, illustration and administration will fulfill the multiple roles needed in a simulation center. The payoffs for healthcare that simulation training provides are increased patient safety, lowered risks, employee retention, and substantial cost savings on liability insurance for both the hospital and physician. Today, simulation technology has matured sufficiently enough that the American College of Surgeons (ACS) has established an accreditation program for institutions incorporating simulation technology that recognizes the facility as an Education Institute. In the near future, the ACS also will be requiring surgeons to be evaluated for re-credentialing as board certified surgeons using simulation scenarios as an evaluation tool.

Historical Background

The current level of simulation technology in healthcare can track its lineage back approximately twenty years. However, the history of medical simulation techniques can be traced back to early Egyptian mythology in the story of Isis saving her husband with mouth-to-mouth resuscitation in 3000 BC, (wherein Isis was simulating breathing for her husband, substituting her lungs for his) (Thangam 1896). Other medical advances that substituted a technique or device to resuscitate the patient are viewed as historic landmarks in the evolution of medical simulation before 1950. But it was not in medicine that the first simulation training device appeared. The rapidly advancing field of aviation is given credit for this with the invention of the Link Trainer in Binghamton, New York by Edwin A. Link. Building his device in the basement of his father's piano and organ factory in 1929, Edwin Link sold most of the early Link simulators to amusement parks (Alanniz 2007). In 1934 the U.S. Army bought six Link trainers, and the future of simulation devices was established.

By 1938 the military purchased over 10,000 Link trainers to train pilots and help minimize the loss of aircraft due to student pilot error.

Move forward to 1958. The Link trainer has advanced right along with the complexity of military aircraft, but now electronics and medical training requirements help shape the future. NASA develops biotelemetry, and a company named Laerdal begins research and development of a mouth-to-mouth resuscitation mannequin. Technology advances through the 1960s, and in the early 1970s Massachusetts General Hospital produces computerized clinical encounter simulations. By the early 1980s the Link Company is making a multitude of military flight simulators, along with models applied to ships and submarines. Interactive video files begin to add dimension to patient encounter simulations, and personal computers make medical simulation much more practical (Piemme 1988).

Along the way, two other groups began investigating the use of simulators for training purposes. The Federal Aviation Administration started to allow the use of cockpit simulators to provide safe training and testing of commercial airline crews for their skills in emergency scenarios. More complex cockpit instrumentation, an increased need for flight safety and survival, and quicker proficiency of aircrews pushed the flight simulator to new levels of sophistication. In the late 1980s the program *Flight Simulator*™ by Microsoft™ was produced for the general public, enabling anyone with a PC to "fly" in a computer-generated airspace. The second group was the military, specifically the medical divisions tasked with providing battlefield emergency treatment of war casualties. They needed a way to train the medics and field hospital medical teams to deal with severe trauma before ever experiencing actual combat, something to give them the confidence to respond correctly and decisively in a hostile environment.

On the surface this seems like two completely different fields with nothing in common. They both, however, deal with events that could be considered as High Risk, Low Occurrence (engine failure, cardiac arrest). The problem does not occur often, but when it does the responding team must be fully competent to recognize and correctly respond to the symptoms. What the airlines found, and the medical profession has also determined, was that there is one primary factor that seemed to determine success or failure – effective communication among the team members. For the air crew, it was solved with a technique called crew resource management. The medical field adopted this concept later, referring to it as team training, but implementing the same verbal communication techniques to assure that each member of the team understood clearly what was going on, and how they were to respond in a particular situation. Clear communication is the best path to success and survival. But it was only because of the use of simulation training that the need for effective communication was identified.

Organizational Structure (Reality in a Virtual World)

So, just what comprises a simulation center? As with any business there is equipment, some type of product, and personnel. Each component contributes in its own way to the mission of the center. In the case of simulation training, there is a wide variety of simulation devices, along with support items such as standard hospital equipment, video cameras, recording devices, and data projectors capable of producing 3-D images. As for the product, it is providing a learning environment for a particular symptom, set of symptoms, or skills for teaching a medical protocol. Once the goal is identified, then the simulation specialist can determine if there is an appropriate simulation technology device or method that will help accomplish the desired result. Equipment and curricula (lessons) are clearly the linchpins to the application of simulation technology in a training environment, but further discussion on these two areas is not the intent of this article. It is the personnel structure of the simulation center that we want to look at, and how biocommunicators may be able to take advantage of their existing knowledge and skills to become a member of the simulation center team.

Each simulation center is "custom-built," with the skills of the personnel varying from center to center. One person can wear one, several, or all of the hats; but a division of labor could look something like this:

- Vice President of Medical Education
- Medical Director
- Education Director
    - Content Developer
- Administrative Manager
    - Administrative Assistants
- Lab Coordinator
    - Simulation Technicians
    - Audio Visual Technician
- 3D Resource Technician

The first position is usually assigned to a physician or PhD with a background in Medical Education. This individual has responsibility for what is taught at the institution, sees that the programs fulfill the requirements for accreditation from the appropriate organizations, and that residents fulfill the criteria for completion of a residency program. Second in line, the Medical Director is a physician whose responsibilities include providing direction to the mission of the simulation center, insuring the medical accuracy of the simulations, and promoting the use of simulation in training. Then there is the Education Director, who is concerned with determining the efficacy of the training for a particular curriculum, accuracy of lesson content relevant to the curricula goals, and developing research projects for the testing of new protocols or performance improvement in order to demonstrate scientifically the value of simulation training for the hospital staff and patients. An Administrative

Manager is responsible for the day-to-day functioning of the lab, its policies and procedures for use, and fiscal accountability. He/she is also in charge of planning future expansions and re-defining the mission of the center, working with a steering committee's recommendations. The manager may be given supervisory responsibilities over the lab personnel to evaluate the daily performance and capabilities of the lab.

A Lab Coordinator is generally recognized as the senior simulation technician, having knowledge and experience with all the devices. The coordinator plans the scheduling of equipment, room assignments for other activities such as a standardized patient training session for new residents, and mass-casualty trauma scenarios. Simulation Technicians, depending on the level of their experience and background, provide the full range of skills required to meet the requests of the clinical educator or researcher. They provide the necessary equipment and run the scenarios when using the various computer-operated human patient simulators. Any two simulation technicians will likely have very different backgrounds to draw upon, depending on the mission of the center and the scope of what it can offer for simulation training.

Two specialty technicians of a simulation center are often overlooked. The Audio Visual Technician maintains the extensive event recording system for all the simulation center rooms, and provides playback capability in the multiple debriefing rooms. This is a formidable task, considering there may be 25 – 30 video cameras located throughout the center, and at least one microphone in each room. Then there is the 3D Resource Technician, who runs what is commonly referred to as the CAVE, an acronym for Computer Assisted Virtual Engineering. This individual creates 3D imagery from two-dimensional information, and presents it for diagnostic and training purposes.

Process and Opportunity

Simulation training is fully dependent on the lesson content as defined by the clinical educator who is a physician, nurse, emergency medical technician, corpsman, etc. The lesson goals will determine which simulation tools could be used to reproduce a particular series of symptoms or anatomical features. The lesson may only require an arm, leg, or chest tissue, for instance, to learn such things as IV insertions, heart sounds, tube insertions, or it may require the more advanced training devices that simulate human physiology. The important thing to remember is that simulation technology is only a tool in the learning process, and is only as effective as the lesson designed by the clinical educator. A particular simulated event might require the most complex services of the simulation center, utilizing the human patient simulator to replicate a life-or-death situation. If the healthcare professional does not perform the proper procedures in a timely manner the simulator will display all the symptoms of a dying person including the ultimate loss of life. It is not unusual to see participants cry at the loss of the simulated patient because the simulation was so realistic. Additionally, one policy that is virtually carved in stone for any simulation center is that the personnel in the lab are not certifying authorities for any of the medical or nursing procedures, or evaluations held there. The content and accuracy of the particular event or task, along with the evaluation of personnel participating in the simulation, is the sole responsibility of the requesting client and department.

Skilled biocommunicators, especially those with knowledge and experience in computer technology, video production, graphic arts, program design, illustration/art, and managerial experience may become valuable contributors to the future of simulation training. Let's look at some of the areas that biocommunicators could take advantage of in the daily operations, and look at it from a process-driven perspective.

This first stage of lesson preparation and planning would benefit greatly from the biocommunicator with expertise in instructional design, an individual who could explain, create and implement an effective presentation for the specific training lesson. As a Content Developer, this individual would identify and evaluate the purpose of the simulation, then decide what equipment is needed to accomplish the task. The goals of every lesson or group of lessons do not necessarily require the use of the more advanced features of the simulation center. A center's primary mission is to provide the level of simulation technology needed to accomplish the desired training, including access to the more complex experiences if necessary, ones that requires a high level of reality to be effective. Appropriately evaluated, some curricula may be assigned to simple clinical skills labs with tabletop trainers with limited function. It is at this point in the process that the requirements of simulation training be accurately identified for proper assignment of resources. Also, the Education Director may be approached by an individual who would like to use simulation to test a particular hypothesis, to do research on a protocol by evaluating an end-user's ability to use new equipment under review, effect a change in methodology, or investigate performance improvement. The individual who has written scripts and proven his/her ability to pay attention to detail, accuracy, continuity and clarity of communication may be an excellent candidate to work in this capacity in simulation training.

Once a simulated event or lesson is approved for implementation, the script is turned over to the Lab Coordinator for programming and scheduling. It is very beneficial for this individual to have experience in clinical healthcare, and especially useful that he/she have a working knowledge of standard treatments as defined by the organization. However, any individual with a background in science could perform this operation. The biocommunicator who has worked with computers could learn the programming and operation requirements for the human patient simulators. Individuals with excellent communication and interpersonal skills will be highly recruited and supervisory experience will be a desirable asset. Biocommunicators who have planned, designed, and created their own presentations for professional meetings will have many of the skill sets and experiences that could be applied in this area.

Now it is time to prepare for and conduct the training event. The Simulation Technician is assigned to the project and the mannequin must be prepared to manifest the symptoms of the particular disease, condition or trauma, the programming run for accuracy with the instructor's final approval, and all supplies and equipment verified to be in working order. To provide an even more realistic scenario, some centers have technicians skilled in the theatrical art of makeup design who prepare moulages in the lab to replicate severe anatomic traumas. Biocommunicators with skills in the graphic arts will be well appreciated for their development of realistic adaptations for the human patient simulators. The simulators come as whole body devices that can be separated at certain points. Realistic looking amputated limbs, severe wounds, compound fractures, and other similar injuries are highly sought after for simulations, and currently are being done by simulation center staff. The medical illustrator/ artist who is skilled in, and enjoys creating three-dimensional art should consider the possibilities in simulation training.

As the event unfolds, it is the Audio Visual Technician who is busy behind the scenes with an impressive array of digital video recording capabilities. The event documentation system is configured for recording the activities during the scenario, utilizing two to five cameras for multiple overhead points of view, and a microphone(s) to capture sound. The instructor is provided a headset for direct communication with the technician back at the control panel throughout the event to clarify when certain symptoms are to be activated, to change the scenario as it progresses, or to pause it at any time. At the end of the event, review of participant action (debriefing) is very important for analysis of accuracy, efficiency, and elimination of future errors due to miscommunication. Large computer-controlled audio video recording systems are available to support such efforts, and often incorporate web access for playback anywhere, anytime. This particular area will potentially have a major impact if there are questions raised about an individual's performance. Biocommunicators with production experience in video, audio, presentation, and computer-controlled operations could prove to be valuable members of the simulation team, assuring maximum performance of the equipment and effectiveness of the training time. Again, excellent skills in communication and attention to detail are necessary for maximizing the success of the event training and perception of the benefit of simulation training. There is another area that simulation is headed in, which will interest the technical biocommunicator and the illustrator. The 3D Resource Technician will have the scientific world at his/her fingertips in creating an image that could not be seen previously.

Simulation centers utilize computers to create imagery from interactive programs such as *The Visible Human*, to develop instructional content, as well as 3D imagery from hundreds of MRI scans to generate realistic graphics that accurately depict anatomical symptoms and conditions. Simulation technology in the CAVE (Computer Assisted Virtual Engineering) environment enables viewing from any perspective, including inside the object. This allows the physician and researcher to see into a world that previously was visible only one plane at a time and stacking of the planes of information had to be done and evaluated in one's mind. One of the more popular programs is aMIRA, (http://www.amiravis.com/) which is used for a wide range of applications including such esoteric ones as fluid dynamics of blood flow through an aneurysm, or detection of a tumor compressing a bronchus. With aMIRA, you could see the external compression by the shape of the bronchus, or you could travel via a movie down through the respiratory system to the point of compression. Take this capability and project it through a pair of projectors aligned for 3-D projection, add a 3-D helmet and you can walk through the anatomy, much like the 1960s movie *Fantastic Voyage*.

Finally, outside the simulation lab activity rooms, there is the daily administration of a center that needs to be run as a business. The simulation center is conducted like any other department that has individuals with various job descriptions and different personalities. Biocommunicators with experience as department managers could comfortably transition into overseeing the activity of a simulation center, and experience serving on professional organizational committees would also be a tremendous advantage. Having a background in any of the biological sciences will be helpful in keeping the mission of the center in perspective, guiding the daily operation of the lab, and preparing the facility for possible expansion of services. Additional skills in marketing, public affairs, and corporate level administration are a must.

Conclusion

Simulation in healthcare can provide new opportunities for biocommunicators to carve out an important niche for themselves in this rapidly expanding field. As healthcare organizations seek ways to improve their safety, increase staff knowledge, provide credentialing certifications for physicians, insure greater patient safety, and assist community services, the future of simulation is very bright. It may even offer an avenue for biocommunicators to clearly demonstrate that they can have a direct impact on patient care.

For those readers interested in simulation technology, there are two books that are worth looking at. The first is *Practical Health Care Simulations*, edited by Loyd, Lake, and Greenberg, published in 2004 by Elsevier Mosby. This work comments on simulation basics, simulation practical applications, and the future of simulation. The second is *Simulators in Critical Care and Beyond*, edited by William F. Dunn, published in 2004 by the Society of Critical Care Medicine. A compendium of individual thoughts, it reveals a broad perspective regarding the application of simulation and the issues surrounding its future in healthcare. Together, these two publications provide an excellent overview of healthcare simulation as it exists today.

We have only begun to scratch the surface here about the field of simulation technology and its impact on healthcare education and safety. Fortunately, there are several key resources for additional information. The best resource is the Society for Simulation in Healthcare, a relatively new organization, comprised mostly of physicians, nurses, emergency medical technicians, and healthcare educators. The association website, www.ssih.org, provides an extensive coverage of topics and issues in simulation, and the listserve is active daily with excellent discussions.

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