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Medical Simulation: Designing for the Future?

Abstract | Article

The history of medical simulations within the healthcare environment began with simple human models and evolved into the use of lifelike mannequins. More recently, interactive models have been utilized for training and assessment. This training method has been well received by the medical community, due to increased retention of core skills. The approach allows the participant to take action to correct errors, thereby creating more successful learning than that offered by passive instruction. Today, interactive models have evolved into computerized simulators that replicate realistic scenarios and react to decisions by participants almost instantaneously. The computerized simulator environment has become a platform for curriculum development within medical education, and used to train and evaluate medical practitioners. The simulation teaching method has been found to reduce preventable medical errors by combating the limitations of the traditional apprenticeship model.

Simulated training is sometimes seen as a limited training model due to the following: simulations often take place in procedural space; professionals taking part in simulated exercises are segregated by department; decentralized simulation practice lacks collaboration and opportunity for evaluation; and new technologies and rapid growth in medical technology make expensive facilities quickly obsolete. To reap the maximum benefits from the cost and practice of medical simulation, health systems must make a commitment to this training method by designating flexible, thoughtfully designed space for this purpose. Henry Ford's Center for Simulation, Education and Research in Detroit provides an example of how to avoid the recognized drawbacks of traditional medical simulation by deliberately choosing a design that is intended to combat such drawbacks.

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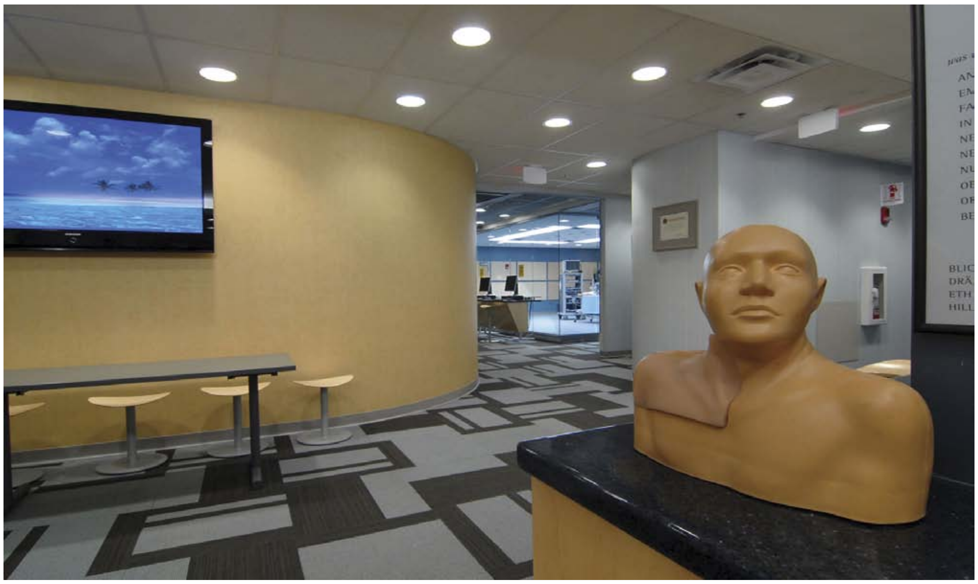

Image 1: Lobby to the Henry Ford Hospital Center for Simulation, Education and Research.Courtesy of Henry Ford Health System

In 2000, the Institute of Medicine published "To Err is Human: Building a Safer Health System," substantiating the danger of fatal, preventable, medical errors in hospitals across the nation and naming them the 8th leading cause of death. The report named clinical simulation the most promising solution to reducing preventable errors and brought national attention to the practice. One of the issues cited within this report was the increasing number of available procedures and their growing complexity. Traditionally, training relied on real-life, hands-on cases that gave professionals learning opportunities. This approach basically left to chance the possibility that the right combination of circumstances would occur in order to give the medical professional an appropriate and well rounded experience-based education. This traditional teaching method, the apprenticeship model, could not possibly keep up with the rapidly expanding technology and procedure repertoire currently being developed.

Image 2: The main hallway is lined with glass walls, which promote collaboration by allowing observers access and views to both the classroom and simulation areas.Courtesy of Henry Ford Health System

Simulation, because of its more widespread use, is now beginning to bridge the gap between conditions professionals might experience in the field and those that are specifically designed for training purposes. As technologies and demand increases, simulations have become more realistic and varied. Due to these developments, healthcare systems need to create appropriate programs to best utilize the latest advancements in treatment and technology. Without careful design and proper implementation of simulation technologies, the full potential of such advances will not be realized.

Image 3: Typical State of the Art Simulated Procedure Room.Courtesy of Henry Ford Health System

Use of Valuable Procedural Space and Departmentalization

One of the major drawbacks of having professionals practice medical simulation is the use of procedural space for simulation purposes. If the same space designated for

procedures is used for simulation, the time frame to engage in simulated training will be limited. Even more difficult is coordinating multiple departments to simultaneously participate in a simulation. If professionals or students are partaking in simulations within their respective discipline, they receive limited exposure to those professionals who may also be involved or assisting in such a procedure. As an example, the traditional training model may have been to train nurses for a cardiac arrest while a physician group did the same, thereby allowing both teams to separately approach a situation on which they will eventually collaborate. This inefficient model does not allow medical professionals to gain insight from one another, nor to effectively communicate with one another, as they would in a real scenario. Although departmental simulation provides a tactile experience for medical professionals, and therefore increases the level of information retained, without collaboration, the scope of the learning experience is limited.

Image 4: 3-D Floor Plan.Courtesy of Hobbs+Black Architects, Inc.

Health systems around the country have found the most viable solution to these issues is to designate space specifically dedicated to simulated training within areas accessible to all of the institution's medical professionals. For example, when Henry Ford Hospital transitioned from paper to electronic medical records, 12,000 square feet of useable space became available in the lower level of the main hospital. The Medical Education and Research Department was able to secure this space for a centralized simulation center, allowing valuable procedural space to no longer be utilized for instructional purposes. The center

creates a centralized, flexible education space with the ability to use present-day, cutting-edge technology. This learning environment emphasizes collaboration amongst all professionals within the health system. The project was designed with the input of various professionals from a variety of departments so that it would meet the specific needs of many different users. "We interviewed nurses, doctors, surgeons, EMTs, and anesthesiologists, among others" states Ann Kenyon, AIA, LEED AP, of Hobbs+Black Associates. "Every facet of the design had to be examined in order to make the space viable for all disciplines." By drawing different points of view from various professionals into one centralized location, the simulation center becomes a more dynamic space, which is extremely valuable for the users and the institution as a whole.

Image 5: Simulated Robotic Operating Room. Courtesy of Henry Ford Health System

Lack of Feedback and Interaction

Another drawback to the practice of decentralized simulation is the difficulty in providing monitoring and feedback. With many professionals of many different disciplines working throughout a hospital, evaluators may have difficulty scheduling time to review and critique performance. Providing monitoring equipment without a centralized location is inefficient, as it will only likely be used by the professionals in that department. Finally, if procedural space is used for simulation purposes, the accommodations for utilizing and storing simulation-specific equipment is likely to make its use, especially with highly complicated and technical simulations, difficult and cumbersome.

Image 6: One-way glass allows proctors to monitor and evaluate performance without interfering with the evaluation process. Courtesy of Henry Ford Health System

Creating one centralized location for simulation practice presents the opportunity to better realize a health system's return on its investment, since the resources allocated in cutting-edge technology will become cost-effective with widespread use of the training space and equipment. This approach also allows the opportunity to integrate monitoring and evaluation technology within the space, which is not possible when utilizing traditional procedural space. Details such as glass walls surrounding simulated ORs can accommodate large groups for simulation observation. The addition of classroom space allows instructors to provide pre- and post-simulation lessons and evaluation, in order to maximize retention of core skills. Henry Ford Health System uses its main classroom, equipped with an adjacent audio/visual control room, for large group instruction. Here, recorded simulations can be played back and reviewed. The smaller debrief room is also designed with this capability. Group instruction can be recorded in the classroom and transmitted to other Henry Ford Health System satellites for system-wide educational purposes. The clinical suites surround a central control room that is used to monitor and proctor simulations. All of the surrounding simulation rooms are equipped with cameras and microphones that are connected back to the central A/V control center for archival purposes. One-way glass between the control rooms and the simulated ORs, ER, ICU and patient rooms allow instructors to proctor simulations out of view of the participants. The proctor and medical professional are able to review and examine, step by step, each facet of the simulation and focus on any details that may require additional instruction. This data can be stored as part of medical professionals' personnel files and becomes a valuable tool that can be used for retraining and retesting purposes.

Image 7: The control room has visual and physical access to surrounding simulation rooms, making observation and evaluation efficient and easy. Courtesy of Henry Ford Health System

Staying on the Cutting Edge

Simulation equipment is not only expensive but rapidly-evolving. With regard to centralized simulation centers, many health systems have concerns about investing in technology and building around equipment that will quickly become obsolete, or creating a facility that does not have the capability to accommodate the new technology that will be developed in the near future. With rapidly-evolving medical technology resulting in changing simulated procedures, and the sheer volume of simulation training, all healthcare facilities face a number of challenges when designing a centralized simulation center.

Image 8: The large classroom can be subdivided by a wall into two learning environments, giving the space the flexibility to adapt to a multitude of programs.Courtesy of Henry Ford Health System

Flexible space is an important design consideration. The

design should accommodate a variety of programs, include space for future expansion, and have the capability to accommodate future technologies. Due to the cost, many institutions are unable build all requirements into the project scope. The space should be designed and engineered to accommodate future expansion and new medical technologies, even those that are not currently part of the financial plan. This will alleviate the need for total renovation should new technology or additional funding become available. As innovations are rarely foreseen, additional space, or flexible space, can also be a great asset to a simulation center. If a health system is ready to invest in a designated space for simulation practice, it is only practical to assume that growth and change are inevitable.

For example, the large, open, Minimally Invasive Simulation Lab at Henry Ford Health System allows for the interchange of up to 18 medical simulations. In addition, this space can be subdivided by a moveable, translucent glass wall that provides visual separation between the user groups, if needed. When designing their new simulation center, the design team intentionally selected a space which had the capability for future expansion. Discussion of the Phase 2 expansion included the addition of three patient exam rooms, two of which would be assigned to orthopedics and could serve as a training area for casting and splinting. The expansion will also include a research area, additional offices, storage space, and a break room for full time simulation center employees. The design team also discussed relocating the microsurgery or cadaver lab within the remaining available space.

An additional flexible OR was designed as the focal point of the space, in the hopes that a robotic operating system could eventually be installed in this location. When the health system acquired a new robot, the existing system was relocated to the simulation center prior to the official grand opening. The forethought of incorporating such a space into the design will allow surgeons to train on the fastest growing, billion-dollar segment of the medical device industry. In addition, further training on such devices will ultimately benefit patients, as the robotic system is known for its precise, tremor-free, and less invasive use of surgical implements, which vastly reduces pain and recovery time. Robots can also benefit surgeons, as they often reduce physical stress and exposure to x-rays.

Image 9: Simulated Operating Room.Courtesy of Henry Ford Health System

As simulation evolves and becomes an accepted practice, it will most likely be used not only for educational purposes, but also for continuing evaluation. Instead of paper tests, which explore fact-based knowledge and neglect to address how well that knowledge is put into practice, healthcare professionals could be tested in a simulation center, where their combined knowledge and skills are the central focus. Already, residency review committees are using simulation-based tests to determine competency. As a result of the pressure on residents to perform well on tests and reviews using simulations, residents have begun to seek out health systems that can offer the latest simulation technologies to better prepare themselves for real world situations. Many health systems have already seen that providing such educational amenities helps to attract and retain top professionals within the medical community. Another inevitable fate of simulation, stemming from its newfound notoriety in the medical community, is growth and increased innovation. New technologies are bound to arise at a rapid pace, and it is in the best interest of every medical institution to determine how these technologies can be incorporated into holistic medical training and eventually medical practice. This is a shared mission of the medical community and the community at large, as each of us benefits from successful medical practice.

Image 10: Translucent retractable walls separate the Minimally Invasive Simulation Lab for a small group to study.Courtesy of Henry Ford Health System

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The Academy Journal is published by the AIA Academy of Architecture for Health (AAH). The Journal is the official publication of the AAH and explores subjects of interest to AIA-AAH members and to others involved in the fields of healthcare architecture, planning, design and construction. www.aia.org/aah

This article originally appeared in The Academy Journal, published by the AIA Academy of Architecture for Healthcare (Volume 11 – September 2008).