An Overview of Medical Simulation Technology

Although still in its nascent stage, this technology has emerged as a safe and practical means of training physicians in high-risk procedures.

BY BARRY T. KATZEN, MD

Medical simulation technology is an emerging modality that allows physicians to achieve significant amounts of tactile and even clinical judgment experience without having to practice on live patients. The concept is akin to applying flight simulation to the medical field. When compared to the applications seen in the field of aviation, however, medical simulation is clearly at a very early stage of its development, both in terms of technology and commercialization. There has been some initial commercialization to date, including adoption by some medical device manufacturers as they begin to look at the future of device training and how the technology will impact their approach.

WHEN AND HOW CAN WE GET OUR HANDS ON IT?

There are a number of hospitals, including our institution, that have an interest in education and are looking at incorporating simulators into on-site educational activities. We currently have one simulator, and we are exploring the possibility of adding two more. Several other facilities in the US are at the same juncture in acquisition. In terms of overall penetration into the medical community, it has to date been fairly limited, but there is an increasing presence at regional and national meetings.

Regarding with whom the responsibility for providing medical simulation training lays, the educational goal of said training must first be defined. If the goal is to become familiar with a specific device and its deployment, which is most often the experience sought when using simulation technology, the manufacturers should be responsible for carrying it out. If the goal is to become experienced in the clinical management of a particular clinical entity, such as carotid artery disease utilizing stents, abdominal aortic aneurysm therapy, or laparoscopic cholecystectomy, for instance, it is more appropriate that the physician or the accrediting body should be responsible as opposed to a specific manufacturer.

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Medical societies are certainly looking at simulation as a way of measuring performance. I can imagine that sometime in the next 10 years, if someone were getting a certificate in interventional cardiology, for example, he would have to take an exam and then go into a simulator to show that he could perform a coronary angioplasty and stenting without hurting someone.

There are also models of shared economic burden, depending on the alignment of incentives. One thing that is important to understand is that this technology represents a broad spectrum of simulation capabilities and achievable goals—everything from providing just a little tactile sensation for deployment of a device to learning what it is like to have a cardiac arrest during a procedure, as well as having to manage it and administer medications, etc. Considering the extent to which this technology can be incorporated into training, it is proba-

bly not entirely fair to assign the economic responsibility to any one particular interested party. Determining who will absorb the cost for simulation training is ultimately dependent on the educational goal and objectives.

Medical simulation will surely have an economic impact on hospitals, accrediting bodies, and physicians. Simulation can help train not only physicians, but also technicians and allied health personnel in procedural aspects such as line placement. Simulators have been used to teach surgical as well as endovascular procedures, so they can be developed and adapted for a number of specific applications. There is frequent discussion regarding patient safety and improving outcomes, and with procedures that are done fairly infrequently, it would be useful to have refresher courses provided, so that physicians can have an ongoing means of maintaining proficiency for some of these less common procedures.

EVALUATING PERFORMANCE

Currently, medical simulation is viewed as something of a curiosity, but one important topic that is not discussed often enough is that simulators can also measure performance. It is not simply a question of a physician having the experience of 10 simulator cases under his belt; it is more important that he execute 10 procedures with adequate performance documented. With medical simulation technology, it is possible to measure the operator's performance against his own benchmark as well as against standard performance. Parameters such as procedure time, fluoro time, and "efficiency" can be defined and measured.

If an institution is developing credentialing or training criteria, and let us say for example the trainee must complete a specific procedure on 25 live patients as well as 25 simulation patients. It will not simply be a case in which the trainee performs 25 simulator cases without killing somebody. Instead, it will be possible to evaluate in finer detail than that: What was the fluoroscopy time? How many catheters were used? It would also be possible to measure performance by scoring the operator according to the percentile of accuracy. In the context of training and credentialing, we will actually have the ability to measure how skilled a doctor really is. Simulators can be used to determine who has manual dexterity and who does not, before finding out on patients. Gallagher et al conducted a study utilizing simulators (virtual reality) to train residents in laparoscopic procedures. Residents who had simulator training performed their procedures on live patients 30% faster and with nine times fewer errors (Data on file, courtesy of Mentice AB, Gothenberg, Sweden).

Another goal of medical simulation is the elimination of learning curves. Learning curves imply elevated complication rates that are reduced with experience. If this experience could be obtained effectively through simulation, one would expect benefit in patient safety and reduced morbidity during early experience.

THE PERFECT COMBINATION

The optimal medical simulation environment is one in which the entire clinical environment is represented. When you sit in the simulator for a 747 nowadays compared to 10 years ago, you see real scenery on the outside, real obstructions, real sky; it is not a computer game. There are no clues that you are actually inside a simulator. You can crash it, you can feel turbulence—you can recreate most of the anxiety-producing events.

In our field, however, perhaps because we are still in the early stage of development, we have not yet seen this kind of real-world-scenario incorporation, although with SimSuite, Medical Simulation Corporation (Englewood, CO), has taken important steps in this direction. Industry thus far is embracing a more limited concept, which is to train people regarding how to use their specific devices. In actuality, the medical profession itself must shoulder the responsibility of actualizing the larger concept of medical simulation. Bodies such as the American College of Surgeons, the American College of Radiology, and the American College of Cardiology, and even medical schools must become involved.

CAN YOU TELL THE DIFFERENCE?

This is not to say that the technology has not already achieved a very high standard of efficacy in its ability to look, sound, and feel absolutely real. At the 2004 ISET meeting, we used a simulator case to convey this take-home message. In a live case presentation, we showed a subclavian angioplasty in a lesion that was proximal to a LIMA graft. There was substantial discussion during the presentation (eg, the patient could have a risk of ischemia, or the heart could be at risk, and there were issues about technique). The subclavian stent was deployed well, with excellent results and no adverse events acutely.

Approximately 15 minutes later, between the scheduled talks, the live presentation returned and reported that the patient had developed chest pain and ventricular arrhythmia. The entire clinical scenario was presented, and the coronary artery with a critical lesion was shown. James Benenati, MD, said, "We've been trying to get a cardiologist, but we can't find one, so I elected to engage the right coronary because the patient is unstable and he had a catheter in." Dr. Benenati proceeded to demonstrate the lesion and perform the angioplasty, all the while saying he was not able to find the cardiologist, which of course was

not the case. The Director of Interventional Cardiology at Miami Cardiac and Vascular Institute was in the front row and had not been clued in to this. After all the gasps from the audience, the camera pulled back to a wide angle and showed that Dr. Benenati was actually in the CT room using a simulator.

The point of our doing this was not for a gag, but rather to change people's minds about simulators. Like many things in life, only once we see something for ourselves can we understand its power. Interestingly, there were many people from different medical societies present, and when they saw what happened, all of a sudden light bulbs went off. If you have neither researched nor experienced medical simulation technology in person, you may have a somewhat skeptical view of it. But once you see a practical demonstration or use the technology yourself, it really is an eye opener.

A TECHNOLOGY OF UNITY, NOT DIVISION

Although it is clear that simulation will be of equal value to all disciplines, there is a perception now that surgeons need such training more than radiologists or cardiologists do. I believe this is only true in a very narrow sense at present. For example, one dilemma arising in radiology training programs is the question of how people will learn interventions without diagnostic angiography, when the foundation of catheter-based training disappears because of the shift to invasive imaging. Every group will face the same types of specialty-specific problems. With carotid stenting, there is a new procedure that perhaps 200 to 250 doctors in the US are qualified to perform. How do we increase that number to 3,000? And how do we make that jump safely, with patient protection?

Across the specialties, all physicians should appreciate the importance simulators will have in our lives in the future. This technology will be important for medical students and practitioners, far beyond the credentialing issues we are currently facing. We will soon see fundamental changes in how physicians receive training and maintain proficiency over the long term. This applies equally to all procedure-oriented disciplines in medicine. ■

Barry T. Katzen, MD, is the Founder and Medical Director of the Baptist Cardiac & Vascular Institute, an affiliate of Baptist Health Systems of South Florida; and Clinical Professor of Radiology at the University of Miami School of Medicine in Miami, Florida. He has not disclosed a financial interest in any product or manufacturer mentioned herein. Dr. Katzen may be reached at (786) 596-5990; btkatzen@aol.com.