

Medical Simulation Hailed as Next Revolution in Radiology Training

LAST FALL at the University of Arizona (U.A.) College of Medicine in Tucson, a CT technician notified a radiology resident of a patient's reaction to contrast medium. The resident talked to the patient, who reported feeling itchy. The resident administered Benadryl, but the patient's blood pressure and heart rate increased. Next trying epinephrine, the resident found the patient starting to wheeze. The resident put the patient on oxygen, to little effect. Faced with the prospect of anaphylactic shock, the resident decided to intubate the patient and, for the first time in his career, performed the procedure on his own.

Tense though the situation was, it didn't take place in the hospital and nobody was at risk. The drama unfolded in U.A.'s simulation laboratory, where residents learn to perform and manage procedures on various devices. The hybrid simulator used in this case combines computers with interface devices, such as automated mannequins, to create close-to-real-life practice situations.

The whole scenario, including the intubation procedure, was extremely realistic, said Elizabeth A. Krupinski, Ph.D., a research professor in the Department of Radiology Research at U.A. "You could see the resident's stress levels rising," said Dr. Krupinski, who designed the training with William Berger, M.D., director of U.A.'s Diagnostic Radiology Residency Program. Each session is videotaped and reviewed with the resident



University of Arizona radiology resident Josh Morais, M.D., performs endotracheal intubation as he manages a simulated life-threatening reaction to iodinated contrast material in the Arizona Simulation Technology and Education Center. At left is Alyson E. Knapp, Sim Lab program coordinator and curriculum developer. In this scenario, Knapp serves as a radiologic technologist assisting Dr. Morais in managing the patient.

performing the simulated procedures. The resident then receives more training to correct mistakes and then repeats the simulation.

The Arizona Simulation Technology and Education Center, known as the SimLab, is in the vanguard of a young and growing field. Interventional radiologists in particular have increasing interest in simulation, especially for its potential to provide training without patient risk, said Gary J. Becker, M.D., professor of vascular and interventional radiology at U.A.

"It moves the entire learning experience, with diagnosis and treatment

under stress, to a low-stakes environment away from the patient's bedside," said Dr. Becker, 2007 RSNA Board Chairman and an associate executive director of the American Board of Radiology (ABR).

Procedural simulation in medicine began with anesthesiology and resuscitation training in the 1980s, and its use in interventional radiology goes back about a decade. Only three small companies now make interventional radiology simulators, all for training in image-guided interventions such as carotid stenting and angioplasty. Some also simulate endovascular procedures in the leg or kidney.

Growth Areas

Other applications are on the horizon, said Steven Dawson, M.D., associate

It moves the entire learning experience, with diagnosis and treatment under stress, to a low-stakes environment away from the patient's bedside.

Gary J. Becker, M.D.

Continued on next page

Continued from previous page

professor of radiology at Harvard Medical School and program lead for medical simulation at Massachusetts General Hospital's Center for Integration of Medicine and Innovative Technology. Managing rare but dangerous situations like the contrast medium reaction is one example.

Another application is managing stroke in its early stages. If more first responders were trained to perform endovascular procedures, many more strokes could be halted and their effects reversed, said Dr. Dawson, a presenter at "Oncologic Image-Guided Interventions: Opportunities for Collaboration," a conference held in February in Washington to encourage collaboration among industry, academia and federal agencies. "It is a growth area and could have a huge public health impact," he said.

Another growth area is patient-specific simulation—placing a patient's

CT or MR images on a simulator and rehearsing a procedure just prior to performing it. The first such "virtual reality" carotid stenting took place recently at Emory Hospitals in Atlanta, as reported by Christopher Cates, M.D., and colleagues in the Jan. 17, 2007, issue of *The Journal of the American Medical Association*.

Caps on residents' work hours, the trend toward more outpatient procedures and the increase in noninvasive diagnostic procedures have all

decreased the direct contact radiology residents have with patients, said experts. Simulation can help fill the gap.

Simulation's unique advantages, such as its potential to measure performance, also make it attractive in cer-

tification examinations, said Dr. Becker. The ABR Foundation just took its first step in that direction with a grant to James Duncan, M.D., Ph.D., an assistant professor of radiology at Washington University in St. Louis, to develop image-guided biopsy simulation with cross-sectional imaging as part of the certification exam.

Simulation could also help measure milestone achievement during residency. "The need to integrate skills and reach milestones within the context of graduate medical education can be satisfied in large measure by simulation once we have a robust menu of simulators that can do what we need them to do," said Dr. Becker.

Next Steps

How to get that robust menu is the overall challenge facing the young field. Endovascular simulators are still in their infancy—some use fluoroscopic images that are somewhat lifelike, but there are still many nuances of feedback and control in real-life patients that simulators cannot yet provide, Dr. Becker said.

Given the limited applications offered so far, little planning has gone into where simulation can fit into a comprehensive course curriculum. As improvements are made in simulator technology and new applications are developed, the challenge will be to design course-specific simulators that can also provide performance evaluation.

The Joint International Simulation Task Force, which includes RSNA, the Cardiovascular and Interventional Society of Europe (CIRSE) and Society of Interventional Radiology (SIR), has outlined steps needed to meet these challenges. They include offering validation—proof that the skills acquired in simulation do transfer to patient care—as well as establishing performance



Elizabeth A. Krupinski, Ph.D.
University of Arizona

measures and identifying points in the curriculum at which to insert simulation.

For now, the task force recommends that simulation be limited to certain early stages of training, such as teaching the correct sequencing of steps in a procedure. Simulation cannot yet be regarded as equivalent to training on actual patients due

to the lack of validation, according to task force guidelines published in the February 2006 issue of the *Journal of Vascular and Interventional Radiology*.

The task force emphasized that simulation will never replace managing real patients. Nevertheless, task force leaders Derek Gould, M.D., of CIRSE and Aalpen A. Patel, M.D., of SIR, giving a joint presentation at the Medicine Meets Virtual Reality meeting in Long Beach, Calif., in February 2007, articulated an optimistic vision. By 2010, they said, "a growing number of validated interventional radiology simulation training modules will have been shown to transfer skills and reduce procedural error, be delivering clinical benefit to patients and have been integrated into a standardized interventional radiology training curriculum and certifying exam."

Creating simulators to meet this vision will take experts in various fields, said Dr. Dawson, currently the U.S. leader for the task force. "Huge challenges revolve around issues of physics, mathematics, computer graphics and physiology models," he said, adding that educational psychologists and others in the human factors fields are also needed to design simulators that are educationally sound with defined metrics and performance indicators.

"It's a daunting task," he said, "but one worthy of national attention." □

Learn More

Additional information about the institutions, conferences and articles mentioned in this story is available online.

■ Arizona Simulation Technology and Education Center
www.astec.arizona.edu

■ Medicine Meets Virtual Reality 15
www.nextmed.com/mmvr_virtual_reality.html

■ "Use of Virtual Reality Simulation for Mission Rehearsal for Carotid Stenting"
jama.ama-assn.org/cgi/content/extract/297/3/265-a

■ "Simulation Devices in Interventional Radiology: Validation Pending"
www.jvir.org/cgi/content/full/17/2/215