Medical Simulation Gets Real

Rebecca Voelker

LAST WINTER, BEFORE THE DRAMA OF health system reform took on nearly Shakespearean proportions, Democrats and Republicans managed to agree on at least one legislative objective that aims to improve patient safety, medical education, and clinical skill.

The proposals—a bill in the House, HR 855, and its same-language companion in the Senate, S 616—are not a formal part of Congress's massive reform effort. But they attracted 18 bipartisan co-sponsors in asking Congress to increase federal funding for medical simulation techniques in academic medical centers and other clinical settings. Emerging research shows that simulation is a valuable training tool that, in some applications, can improve patient outcomes.

The future of the bills is in limbo. Both have been referred to committees in the House and Senate, where they may come up for debate or they may languish and die. Either way, the legislation shows that after steady growth over the past decade, the use of medical simulation now has the potential to change the face of medical education and clinical practice.

"We would like simulation to be embedded in the fabric of how we do health care," says David Gaba, MD, a pioneer in the field who is associate dean for Immersive and Simulation-based Learning at the Stanford University School of Medicine, Stanford, Calif. He also is treasurer of Advanced Initiatives in Medical Simulation, a coalition that promotes simulation techniques and helped craft the bills now pending in Congress.

40 YEARS AND COUNTING

A 1967 article in *Time* magazine heralded the creation of Sim One, a life-sized "robot" complete with vital signs that was designed to simulate clinical encounters in anesthesiology training at Los Angeles County General Hospital in California. But a few years after development, "it kind of died out," says Gaba.

Today, Sim One's descendants usually are called mannequins or simulators rather than robots. Some have names—Susie, Stan, Noelle, and Harvey, for example. They have attributes similar to those of their forerunner: vital signs, blinking eyes, teeth, responses to medications, and the ability to go into cardiac arrest or vomit.

But newer simulators are more anatomically lifelike. They have multiple detectable blood pressure points, pupils that respond to light, pores and hair follicles, heart and bowel sounds, breathing lungs, and chests that flail. They can cry, urinate, bleed, respond to chest compressions, suffer a collapsed lung, have a seizure, develop drug allergies, and give birth to an infant simulator. Many, if not most, are wireless.

Not all simulators are full-body mannequins. Some are partial task trainers—a mannequin arm or torso, for example—that allow clinicians to focus on a specific skill such as suturing or chest tube placement.

"There has been a proliferation of simulation devices to address many different procedures and many different domains of health care," says Gaba.

Other simulators are not devices at all. Specially trained actors, often called standardized patients, participate in role-playing and communications training. Sessions may be videotaped so clinicians in training can review and learn from their own performance. Computer and virtual reality technologies are included in simulation training technologies, too.

Some training programs also use hybrid simulation techniques, in which an actor or a health professional plays the patient's role while students or residents perform procedures on a partial

Jim Ziv/Northwestern University

John Vozenilek, MD (right), teaches clinical skills using a full-body simulator at Northwestern University's Feinberg School of Medicine in Chicago. Use of simulation techniques to improve clinicians' abilities and patient safety has grown rapidly over the past decade.

task trainer. For example, a labor and delivery nurse acts as the patient, crying out in pain, while students handle complications in labor and delivery with a female birthing simulator.

INCREASE IN USE

The past decade has seen a rapid increase in the number of academic medical centers, hospitals, and clinics that use simulation techniques to train clinicians in tasks ranging from informing patients of a medical error to performing thoracentesis.

Robin Wootten, MBA, RN, executive director of the Tipton, Mo–based Society for Simulation in Healthcare, says the field began to make strides in the mid-1990s. But the use of simulation really took off after the Institute of Medicine released its landmark report on medical errors and patient safety, *To Err Is Human: Building a Safer Health System*, in 1999.

The report, says Wootten, "mentioned simulation several times." Soon after its release, she adds, "that's when I saw the huge boom."

Don Berwick, MD, president and chief executive officer of the Institute for Healthcare Improvement, Cambridge, Mass, and a member of the committee that produced *To Err Is Human*, calls medical simulation "one of the most exciting areas of [health care] improvement, especially in patient safety and liability."

Research is beginning to show how widespread medical simulation has become.

Investigators at the Mount Sinai School of Medicine of New York University in New York City surveyed 134 emergency medicine residency programs in 2008 and found that 91% used some form of simulation in training. Almost as many, 85%, specifically used mannequins, up from 29% in 2003. And 43% of the programs owned their own mannequins, up from 8% in 2003 (Okuda Y et al. *Acad Emerg Med*. 2008;15[11]:1113-1116).

"We've definitely seen growth, but my sense now is that simulation is popping up everywhere," says John Vozenilek, MD, director of Simulation Technology and Immersive Learning at Northwestern University's Feinberg School of Medicine in Chicago. Northwestern, in fact, is building a 7000-square-foot expansion of its simulation facilities.

One of the simulators that Vozenilek and his colleagues use in training programs for medical students and residents is Noelle, a childbirth simulator. But Noelle is used for more than simulating labor and delivery. During a teaching session on neurological disorders, the simulator plays the role of a 43-year-old woman who arrives in the emergency department having seizures.

Vozenilek drills third-year residents Anne Chung, MD, and Ashley Peko, MD, on possible causes for the seizures after providing a brief patient history. Chung administers oxygen while she and Peko discuss the possibilities and narrow their diagnosis to toxic alcohol ingestion. "You're nailing it," says Vozenilek.

SHOW ME THE DATA

Among the greatest challenges for simulation researchers is determining whether simulation training can translate into improved patient outcomes. "There are a few cases starting to come out, but they have mostly to do with narrow procedures," says Gaba.

One study from Northwestern investigators reported on 92 residents who received simulation training in central venous catheter (CVC) insertion. The rate of bloodstream infections from catheters the residents inserted in an adult intensive care unit (ICU) decreased during a 32-month period to 0.50 per 1000 catheter-days compared with 3.20 per 1000 catheter-days before the training. In another ICU in the same hospital, the catheter-related infection rate was 5.03 per 1000 catheter-days (Barsuk JH et al. *Arch Intern Med*. 2009;169[15]:1420-1423).

For now, however, much of the recent research examines whether or how simulation training enhances clinical skill. Another Northwestern study of 41 internal medicine residents showed that those who were simulator-trained needed fewer needle passes to insert a CVC and were more confident about their procedural skills compared with residents who received traditional training (Barsuk JH et al. *J Hosp Med*. 2009;4[7]:397-403).

Researchers in Denmark examined whether virtual reality training could improve residents' skills in performing laparoscopic salpingectomy. Their study compared 11 residents trained with a virtual reality simulator with 10 who received standard training. The simulator-trained residents achieved a proficiency level equivalent to having performed between 20 and 50 procedures; the traditionally trained residents' proficiency level was equal to having performed fewer than 5 procedures. Median operating time for the simulator-trained group was 12 minutes compared with 24 minutes for those who received standard training (Larsen CR et al. *BMJ*. doi:10.1136/bmj.b1802).

In 2006, the federal Agency for Healthcare Research and Quality (AHRQ) awarded $5 million in grants for 19 simulation research projects. One of the grants went to Jacqueline Moss, PhD, RN, assistant dean for Clinical Simulation and Technology at the University of Alabama School of Nursing, Birmingham. Her research examines ways to reduce medication errors, a main safety issue addressed in *To Err Is Human*.

Moss's data tracked 34 nurses' work practices and analyzed 553 administrations of intravenous medication during a 6-month period in 5 ICUs. These observations in the first phase of the study helped Moss and her colleagues develop a simulation using mannequins to determine whether a decision-support device with medication alerts and hyperlinks to reference information can help nurses reduce medication errors.

"Using simulation for this kind of research is so powerful," explains Moss. "We're able to test the effect of possible interventions in a simulated environment without endangering the patient. In the practice setting, there could be unintended consequences. This is a much safer way."

If the bills pending in Congress are passed, the AHRQ could become more directly involved in simulation research. The current legislative language calls for the agency's director to award additional grants as well as establish medical simulation centers of excellence. "The level of interest in simulation is very high in the agency," says Kerm Henriksen, PhD, a human factors advisor in the AHRQ's Center for Quality Improvement and Patient Safety.

The bills ask for $50 million in fiscal year 2010 and unspecified amounts annually through 2014. "It's a drop in the bucket," says Gaba, noting that these are authorization bills; appropriations bills for funding have not been written. ☐

Task Force: Nontraditional Markers Add Little to Heart Risk Assessment

Mike Mitka

TOO OFTEN, TRADITIONAL METHods for assessing risk of coronary heart disease in asymptomatic patients wrongly identify some healthy individuals as high risk, while missing impending problems in others. Overtreatment can mean unnecessary costs and increased anxiety for those diagnosed, while undertreatment can lead to myocardial infarctions and death. Researchers have therefore begun to examine nontraditional markers in hopes of finding more accurate screening tools.

But analysis of these nontraditional markers has produced insufficient evidence to support their routine use, said the US Preventive Services Task Force in a recommendation statement released October 5 (US Preventive Services Task Force. *Ann Intern Med.* 2009;151[7]:474-482). The markers considered were high-sensitivity C-reactive protein (CRP), ankle-brachial index (ABI), leukocyte count, fasting blood glucose, periodontal disease, carotid intima-media thickness, coronary artery calcification score on electron-beam computed tomography (CAC), homocysteine, and lipoprotein(a).

The gold standard for coronary heart disease risk assessment is the Framingham risk scoring system, which calculates an individual's 10-year percentage risk of myocardial infarction or coronary death based on age, gender, levels of total cholesterol and high-density lipoprotein cholesterol, smoking status, and blood pressure readings. Individuals are stratified to 3 risk levels: low (less than 10%), intermediate (10% to 20%), or high (more than 20%).

Patients at high risk obviously need treatment, while those at low risk need only a congratulatory handshake and a reminder to maintain a healthy lifestyle. The problem for physicians comes with those at intermediate risk—"the Framingham's no-man's land," said Ned Calonge, MD, MPH, the task force chair, in explaining why the group decided to study nontraditional coronary heart disease markers.

Measuring the ankle brachial index and other nontraditional risk assessments for coronary heart disease should not be used routinely, said the US Preventive Services Task Force.

"For the most part, we were able to say the risk factors were indeed associated with heart disease, but just saying a metric is associated with an outcome is in no way enough to say, 'Let's use these to screen for disease,'" said Calonge.

The task force did say that a supporting document it used in its analysis found strong evidence that CRP is associated with coronary heart disease events, as well as moderately consistent evidence that adding CRP to risk prediction models improves risk stratification among individuals in Framingham's intermediate-risk category. However, there is not yet sufficient evidence that reducing CRP levels prevents coronary heart disease events (Buckley DI et al. *Ann Intern Med.* 2009;151[7]:483-495).

"The studies available [on CRP] make it difficult to determine how many people will be reclassified and benefit," said Calonge, who is also the chief medical officer for the Colorado Department of Public Health and Environment in Denver.

Task force recommendations tend to err on the side of caution, and physicians seeking additional information for treatment strategies do not necessarily embrace its findings.

"The standard they are looking for is a study or a series of studies that tests strategies that would have a proven impact on medical outcomes, and the fact that a test might improve a predictive model is not good enough for the US Preventive Services Task Force," said Philip Greenland, MD, professor of medicine at the Northwestern University Feinberg School of Medicine in Chicago. "I do not think this should be interpreted as meaning it should never be

