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Clinical Simulation: Importance to the Internal Medicine Educational Mission

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Medical education in the United States is constantly evolving. However, some aspects have remained unchanged since the Flexner Report of 1910. One aspect that hasn't changed is the strong apprenticeship component of clinical education during which medical students and residents train in academically oriented hospitals supervised by faculty physicians.[1] Recently, this apprenticeship model for medical education began undergoing an extreme makeover.[2,3]

Beginning in 2001, the Accreditation Council for Graduate Medical Education (ACGME) Outcome Project required residency programs to provide education and competency assessment of each resident in 6 core competencies: Patient Care, Medical Knowledge, Communication, Professionalism, Practice-Based Learning and Improvement, and Systems-Based Practice.[2] The Liaison Committee for Medical Education has similar expectations for the evaluation of undergraduate medical education.[4]

Medical knowledge is expanding at a much faster rate than it can be learned. One solution for medical educators and trainees to minimize potential knowledge gaps has been to lengthen the duration of training and to increase specialization. The Liaison Committee for Medical Education and ACGME also have responded by increasing the curricular mandates to medical schools and residency training programs. However, increased curricular mandates and longer, more specialized training have natural limitations.

Patient safety is now a national priority, and patient safety education will need to follow this movement. Following the publication of the Institute of Medicine report, *To Err is Human,* the federal government and health care providers made a significant financial commitment to creating a safer system of care.[5] Many of the preventable medical errors involve faulty systems of care, lack of standardization in practice, poor communication, and lack of teamwork among health care providers.[6]

High-fidelity simulation (full-body mannequin robots that breathe, talk, blink, and respond physiologically "like a real person") provides an opportunity to compress the learning time in medicine through a high quality experiential learning environment.[7] The curriculum can be taught in a reproducible and emotionally engaging manner that significantly enhances understanding and retention, and reduces gaps in knowledge and skills.[8] A high-fidelity simulation program can reproducibly teach and assess most, if not all, of the ACGME competencies under direct observation. Patient safety issues can be simulated and practiced so that mastery of skills occurs in a safe environment. Mistakes can occur without "real life" consequences. High-fidelity patient simulation has been described as a method to not only teach, but evaluate while replicating a variety of clinical encounters.[9-12]

A comprehensive simulation program should become as natural to medical education as teaching

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rounds and morning report. Because internal medicine has traditionally led the education of medical students and educational reform, internal medicine should also lead in simulation education.

THE CASE FOR SIMULATION

Systematically designed simulations are not new. They have been employed since ancient times in those pursuits where training and testing in the real world have been too dangerous (eg, war games), too expensive (eg, aviation), or simply unfeasible (eg, space exploration).[13] Educational simulations are analogous to the play of any species. By allowing imitation, the participant can explore, make mistakes, and incorporate corrective feedback as a guide for future action.[8]

Comprehensive patient simulation programs are quickly emerging in many US medical schools.[14] Departments of internal medicine have lagged behind other clinical departments (such as anesthesia and emergency medicine) in the use of high-fidelity simulation for medical education. However, to date, no medical specialty has utilized the full potential of high-fidelity simulation as a teaching tool.

Medical simulation—as a teaching and assessment tool—offers several advantages over traditional patient encounters. First, events can be scripted so that specific curricular objectives are experienced at the same time by all of the trainees. This is possible for both common and rare scenarios.[12] Second, events can be observed in real time and allowed to unfold. Mistakes can occur without endangering patient safety.[11,12,15-18] Third, trainees can be placed under significant pressure where ethical decision-making, cultural awareness, and communication skills must be employed. Finally, clinical simulation allows the opportunity for practice and repetition until a skill is mastered.[11,17,18] In other words, in this setting, the competency of the trainee can be observed and documented. Omissions in the curriculum can be identified. Remediation and practice is possible, until the desired outcome for each trainee can be obtained.

HUMAN PATIENT SIMULATION—HISTORY, STATUS, AND POSSIBILITIES

Simulation training has been a mainstay for training in several high-risk occupations, including aviation, nuclear power, and the military.[14] However, medical education has been slow to adopt simulation technology. Realistic human patient simulators have been available since the 1960s but were expensive and too sophisticated for the users.[14,15] Beginning in the late 1980s, anesthesia mannequins were developed that could generate physiologic changes to mimic critical clinical events. In the last 10 years, mannequin simulators have improved significantly in levels of realism.[14] Simulation mannequins can reproduce physiologic changes associated with unstable cardiac and respiratory conditions, and have advanced airway features that can simulate difficult airway scenarios.

PERSPECTIVES VIEWPOINTS

- Simulation can reproducibly teach and assess ACGME competencies.
- Medical education has been slow to adopt simulation technology, a mainstay for training in several other high-risk occupations.
- Discuss the basic components of and costs and challenges to incorporating simulation technology.

Several partial-task trainers are available that allow practice of technical skills in a safe environment before attempting these procedures on patients. This technology has developed to the point that credentialing for some procedures, such as carotid stenting, now requires demonstration of competency on a simulator before performance on a patient.[19]

Full body mannequins were designed initially for anesthesia training and historically are best suited for dealing with anesthesia and advanced cardiac life support scenarios.[8] Because internal medicine training heavily involves diagnostic skills, simulation scenarios are best done with additional layers, such as obtaining a history using an embedded microphone in the mannequin and using standardized patient actors to play the roles of family members, nurses, or other patients. Scenarios can be scripted to reproduce complex situations, including ethical dilemmas, communication challenges, risk management issues, team dynamics, and cultural challenges. Simulation also is ideal for team training, including rapid response and code teams. It has been the authors' experience that well-scripted simulation can provide trainees with cues and consequences similar to those encountered in the hospital.

High-fidelity simulation is best described as a strategy, not a technology; it is a teaching tool that can be used to mirror, anticipate, or amplify real clinical situations for the purpose of standardizing the curriculum and compressing the timeframe during which experiences are normally encountered. These experiences are designed to promote reflective learning by uncovering and challenging the trainee's otherwise hidden perceptions. Learners can try different strategies to solve problems and practice skills. They also can rehearse the management of serious but infrequent events under controlled, predictable times and places.[8]

COMPONENTS OF A SIMULATION PROGRAM

Simulation requires 3 basic components: a trained faculty member to develop and deliver the curriculum, simulation equipment, and a space that provides adequate realism for the suspension of disbelief. The faculty member's role is to deliver the curriculum using simulation as the tool.

Gordon et al have shown that the same case can be used with any level of trainee as long as the curricular objectives are clear.[7] For example, a case of an inferior myocardial infarction can be used with first- and second-year students to demonstrate cardiac physiology, pathology, or pharmacology. The same case used with third-year students can demonstrate diagnosis, electrocardiogram interpretation, and initial management. For a postgraduate year-1 resident, the case can focus on management and cardiac care unit (CCU) care; with upper level residents, the emphasis can shift to advanced cardiac care, management of shock, or code team training.[7]

Different simulation equipment can be used depending upon the goals of the session. Sessions can be designed primarily for education, training (practice), evaluation, or combinations of the above. Examples of equipment include partial task trainers (such as a lumbar puncture trainer or central line trainer), computer software that runs patient scenarios, virtual reality, and various computerized mannequins. The higher fidelity mannequins, such as SimMan (Laerdal Medical Corporation USA, Gatesville, Tex) and METI (Medical Educational Technologies Inc., Sarasota, Fla), can reproduce vital signs and some physiologic changes. These mannequins have voice capability, allowing oral history-taking, but are limited in terms of physical examination capabilities. Standardized actors can add layers of complexity to scenarios, especially if the goals of the session are to evaluate communication, professionalism, or ethics (Table 1).

Several types of educational scenarios can be built into a simulation program. Sessions can be designed to teach and practice procedures. Code team training, rapid response team training, and critical event scenarios, such as mass casualty or weapons of mass destruction scenarios, can use simulation to teach and practice skills that cannot be taught safely during normal rotations. Scott & White Memorial Hospital recently used simulation to identify response problems and team coordination problems for code teams, working in the context of moving into a new hospital. The hospital simulated unannounced codes with mannequin simulators to uncover logistical problems and improve team coordination.

Table 1 Common Simulation Modalities

Partial task trainers (ie, Lumbar Puncture Trainer)
Standardized patients
Full body task trainers (ie, Resusci Anne)
High fidelity mannequins (ie, SimMan, METI)
Virtual reality
Computer software (ie, MicroSim)

Table 2 Common Types of Scenarios

Task/procedure training (eg, central line insertion, lumbar punctures)
Team training (eg, ACLS, code team training)
Critical event scenarios (eg, difficult airway, WMDs, mass casualties)
Behavioral/cognitive skills training (eg, communication, professionalism, ethics)
Competency assessment

ACLS = advanced cardiac life support; WMD = weapons of mass destruction.

With some imagination, almost anything in the curriculum can be simulated. Simulation is an excellent tool for teaching cultural competence, professionalism, ethics, and communication. Scripted scenarios, using standardized family members, friends, and hospital personnel, have been used to challenge the resident's ethical training and reasoning. These scenarios include unclear end-of-life decisions (patient "codes" with ambiguous code status), conflicts surrounding the transfusion of a patient (patient is unable to communicate but does not have written "do not transfuse" orders), and disclosure of a death to family members. Risk management can be extremely helpful in identifying common at-risk events (Table 2).

Issenberg et al published a systematic review of the essential features of simulation that lead to effective learning, finding that feedback was the most important feature.[20] The authors' experience also has strongly reinforced the concept that all simulation sessions should be followed immediately by a structured debriefing session. During the debriefing session, the learner has an opportunity to reflect on his or her actions and beliefs. The resultant "reflective learning" mirrors the type of learning that occurs with difficult cases in the hospital. An active learner in a stressful situation must make decisions and can immediately see the consequences of those decisions.[20] The authors' motto (adopted from the Harvard Institute for Medical Simulation) is that "simulation is just an excuse for debriefing."[8] Other key features identified by Issenberg et al include repetitive practice, curriculum integration, variation in degree of difficulty, the use of multiple learning strategies, ability to capture clinical variation, and defined outcome measures.[20]

CHALLENGES AND COST

Although simulation is gaining acceptance in medical education, several challenges must be addressed before

a simulation program can become an educational standard. The major challenges include space, time, faculty buy-in, and money.

Many institutions cannot afford to build and maintain a simulation center. Simulation centers are a significant capital expenditure and simulation technology also can be expensive to obtain and maintain. It has been the authors' experience that declining clinical revenue has made educational space more difficult to obtain.

Scott & White Memorial Hospital took advantage of a different strategy, partnering with a community college, Temple College. Temple College constructed a $3 million simulation center within a new $8 million Health Sciences building. Scott & White health system was willing to provide equipment and some of the mannequins, and to share in the annual expense of the center. Temple College uses the center for their surgical technology, respiratory technology, emergency medical technology, and nursing programs. The center also is used for training of residents from Darnall Army Hospital at Fort Hood, Texas, and individuals associated with regional emergency services.

Another significant challenge to simulation is obtaining time for both the trainees and faculty. Residents are essential to patient care and their time has been restricted by ACGME duty hour regulations.[2] Residency directors may be reluctant to move residents away from the inpatient setting into a place that is educationally unfamiliar, especially when the residents are critical to the medical care delivered by the institution.

The authors found faculty, student, resident, and fellow buy-in to be a slow process. Therefore, a schedule was created so that there would be minimal disruption to daily clinical and academic responsibilities.

The faculty buy-in process for medical student learning included overcoming resistance to changing the curriculum and taking time away from other activities. The authors incorporated the simulation course during the outpatient block of the third-year internal medicine clerkship. The curriculum committee did not immediately endorse the time commitment or the curriculum, but allowed a pilot to be conducted. The students strongly endorsed the simulation experience and now the student curriculum committee enthusiastically supports the use of simulation.

Simulation training is now a significant part of the "educational culture" of Scott & White Memorial Hospital, Texas A&M University HSC College of Medicine. The key players in changing attitudes and perceptions were the students and residents who immediately realized the value of simulation training. The simulation program also is part of the recruitment strategy, so the students and residents expect it once they arrive.

The program requires several faculty members to be successful. Within the department of medicine, approximately 1 full-time equivalent (FTE) is dedicated to the program, with time commitments being divided between 4 regular clinical faculty members and a full-time medical educator.

THE FUTURE

The airline industry adopted simulation as a major teaching and evaluation method more than 60 years ago in response to a poor safety record, scrutiny from the Federal Aviation Administration, and incentive to reduce the number of crashes during pilot training. Simulation is now the standard for training and evaluation within the industry. All pilots are required to pass a checkout ride in the simulator before flying the actual plane. They also must recertify at regular intervals and must train and certify when flying any new airplane. As a consequence, the airline industry has an enviable safety record.

Simulation should become as natural for physicians as it is for pilots. Most procedures can be simulated by novices before they are attempted on patients. The fidelity of partial task trainers and virtual reality trainers is rapidly improving and is realistic enough for practice and basic skill acquisition.[21] Although simulation is not universally practical today, all procedural skills should eventually be simulated and practiced up to a basic level of competency before they are ever attempted on patients. In the near future it should become unthinkable for trainees to practice and acquire basic skills on patients.

As the patient safety movement matures, simulation will most likely play a significant role in ongoing training and recertification. For example, the airline industry shares all data about crashes and near misses. All of those events are carefully evaluated along with the basic procedures and systems that may have contributed to the crash. If the problem was procedural, the standard procedures are then changed. The whole process then is brought to the simulator and becomes a part of normal training and recertification (personal communication with J.E. Buttry, retired American Airlines Captain of 16 years, on January 12, 2006).

The same process could be used with medical simulation. Risk management cases can be evaluated in the same way as airline crashes. Subsequent procedural changes could be simulated and become part of the certification process. Overcoming cultural obstacles, such as sharing risk management data and standardization of hospital procedures, will be daunting, but the health care industry cannot continue to tolerate mistakes and preventable deaths as the cost of an imperfect system.

An important use of clinical simulation as a teaching tool is its ability to define and create a "critical inci-

dent" in which a medical learner is made aware of or recognizes an area of clinical deficiency and therefore becomes motivated to learn and incorporate new knowledge.[22] Simulation should be a core element in the education of the physician throughout the educational continuum. In the earlier stages of medical school, simulation can be used to introduce physiological and pathological concepts and to practice clinical skills. Later in medical school, simulation can be used to provide standardization to the curriculum, to teach technical skills, and to observe noncognitive skills. Residents and faculty can benefit greatly from simulation for all the reasons listed above, as well as to practice skills and react to serious events that are usually rare in clinical presentation. The same scenarios can be used throughout the educational continuum by simply varying the level of complexity and by adding confounding factors.

Clinical simulation also allows for complex areas of previously acquired medical information, skill sets, and professional behaviors to be integrated. Discernment and retention can occur more efficiently than with conventional teaching methods, particularly when it comes to the areas of clinical ethics, professionalism, and communication skills.[7] Finally, simulation offers a standardized, reproducible method for delivery of competency education. Simulation also allows for direct observation of residents and students in stressful situations.

Internal medicine should take a leading role in this revolution. Since the days of Sir William Osler, internal medicine has been a leader in the clinical education of medical students and residents. Simulation should be no exception. This educational method will become the standard for competency assessment in the near future and be as routine for the continuum of physician education as it is for aviation and other high stakes professions. With departments of internal medicine leading the way, internal medicine training programs can train a better, safer, and more competent physician for the 21st century.

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