HOD ACTION: Council on Medical Education Report 8 adopted and the remainder of the report filed.

REPORT OF THE COUNCIL ON MEDICAL EDUCATION

CME Report 8-A-09

Subject: Update on the Uses of Simulation in Medical Education

Presented by: Claudette E. Dalton, MD, Chair

Referred to: Reference Committee C
(Rodney G. Hood, MD, Chair)

Council on Medical Education Report 15, A-07, "Uses of Simulation in Medical Education—to Simulate or not to Simulate?" recommends in part that the American Medical Association (AMA), through its Council on Medical Education, monitor the developments in uses of simulation and simulators in physician preparation for entry and re-entry into clinical practice, and provide a report back at the 2009 Annual Meeting of the AMA House of Delegates. That report defined simulation and provided a comprehensive overview of the effectiveness of simulation in learning. This report provides an update on the integration of simulation applications in medical education programs and assessments of clinical skills.

BACKGROUND

Simulations and simulators have become effective learning, teaching, and assessment tools. Multiple types of simulations and simulators are increasingly being integrated into educational curricula, and used in simulation centers located at US medical schools and teaching hospitals. Simulations include devices, trained persons, lifelike virtual environments, and contrived social situations that mimic problems, events, or conditions that arise in professional encounters.[1]

Simulation technologies range from using simulated patients or actors to help learners develop communication skills, to the use of virtual reality simulations to facilitate graduate and postgraduate physicians developing surgical technical skills required for performing minimally invasive surgeries. Simulations of clinical environments allow rehearsals of entire surgical operations or disaster scenarios, including opportunities for team preparation to handle possible errors and complications.

Mannequin simulators have evolved from simple, passive anatomical models to computer-driven, screen-based, interactive and physiologically realistic instructional tools. In its new simulation center, West Virginia University School of Medicine is planning to showcase mannequin "patients" capable of more than 72,000 human reactions—everything from trembling and sweating, to bleeding or giving birth.[2] A recent study showed that more than 80 percent of emergency medicine residency programs are now using mannequin-simulations.[3]

Inclusion of simulation in high-stakes national examinations has stimulated many changes in medical training programs, including the introduction of a host of curricular changes and a new-found emphasis on the importance of communication skills.[4] However, although multiple simulators have been validated as effective training tools, many training programs struggle to incorporate simulation into their residency curricula.[5]

ASSESSMENT OF CLINICAL SKILLS

In a recent study to review high-stakes simulation-based assessments, Boulet et al. reported that simulation-based summative assessment of clinical skills was viable, even with large examinee populations, differing testing purposes, and varying examination administration protocols.[6]

The United States Medical Licensing Examination (USMLE) Step 3 assessment contains computer-based case simulations. USMLE Step 2 Clinical Skills (CS), a multistation standardized patient-based evaluation, uses simulated clinical encounters to assess medical students' basic clinical skills. More than 120,000 examinations have been administered, representing more than 1.4 million examinee-standardized patient encounters since USMLE Step 2 CS became operational almost 4 years ago.[6] Numerous medical schools have changed the objectives, content, and emphasis of their pre-clinical curriculum in response to the implementation of USMLE Step 2 CS.[4]

The National Board of Osteopathic Medical Examiners also uses standardized patient encounters in the Comprehensive Osteopathic Medical Licensing Examination. Simulations, in a broad context, are also used as part of specialty board certification, and were recently introduced as part of maintenance of certification (MOC). Interventional cardiology diplomats can now earn credit toward completion of the Self-Evaluation of Medical Knowledge requirement for MOC by completing the interventional Cardiology Simulations developed by the American Board of Internal Medicine.[7]

In developing these simulation-based assessments, testing organizations were able to promote novel test administration protocols, build enhanced assessment rubrics, advance sophisticated scoring and equating algorithms, and promote innovative standard-setting methods.[4] Despite psychometric and security challenges, Dillon and Clauser reported that the addition of the computer-based case simulation test format to the USMLE has allowed for a significant expansion in ways to assess examinees on their diagnostic decision making and therapeutic intervention skills, and on developing and implementing a reasonable patient management plan.[8]

CURRENT EDUCATIONAL PROGRAMS

Simulation has become common in training in many medical subspecialties and has been incorporated into many areas of both undergraduate and graduate medical education (GME). Currently it is widely used to teach surgery, emergency medicine, anesthesiology, and intensive care medicine. Computer technology has allowed for a vast array of programs that can simulate such things as the physiology, pharmacology, and detailed human anatomy. Technologies have become more compact, and the increased use of wireless devices has improved performance. Programs, such as The Visible Human Project, a multicenter database of computed tomography (CT) scan images of complete human anatomy, provide an interactive exploration of the human body without the need for dissection of a cadaver.[9]

Recent initiatives to integrate simulation applications in medical education include:

The Society for Simulation in Healthcare
http://www.ssih.org/public/index.php?ijejifeijfeijfwf=qhuihqwiduhqwiufe&page=website_links
The Society for Simulation in Healthcare (SSH) represents the rapidly growing group of educators and researchers who utilize a variety of simulation techniques for education, testing, and research in health care. SSH is a broad-based, multi-disciplinary, multi-specialty, international society with ties to all medical specialties, nursing, allied health paramedical personnel, and industry. A major venue for advancing simulation in medicine is the annual International Meeting for Simulation in

Healthcare (formerly IMMS). SSH promotes improvements in simulation technology, educational methods, practitioner assessment, and patient safety that promote better patient care and can improve patient outcome. SSH maintains a list of US medical schools and training programs (with their web sites) that have simulation centers.

The American College of Surgeons Program for Accreditation of Education Institutes
http://www.facs.org/education/accreditationprogram/list.html
The American College of Surgeons (ACS) Accredited Education Institutes has created a network of ACS-approved regional Education Institutes that offer practicing surgeons, surgical residents, medical students, and members of the surgical team a spectrum of educational opportunities including those that address acquisition and maintenance of skills; and focus on new procedures and emerging technologies. The goal of the ACS Accredited Education Institutes is to focus on competencies and to specifically address the teaching, learning, and assessment of technical skills using state-of-the-art educational methods and technology. The Education Institutes uses a variety of methods to achieve specific educational outcomes, including the use of bench models, simulations, simulators, and virtual reality. These programs meet the requirements of the ACS Program for Accreditation of Education Institutes, and are accredited as Level I ACS Accredited Education Institutes for three years. The ACS web site provides a listing of ACS Accredited Education Institutes.

The Society for Academic Emergency Medicine
http://www.saem.org/saemdnn/Home/Communities/InterestGroups/Simulation/tabid/138/Default.aspx
The Society for Academic Emergency Medicine (SAEM) has a special interest group on simulation that maintains a resource-rich website. In addition to the SAEM Simulation Interest Group newsletter, SAEM maintains Emergency Medicine Simulation Resources Online (http://www.emedu.org/sim/resourz.htm). Resources include links to US simulation centers, a simulation case library, simulation case templates, a graphics library (electrocardiograms, radiographs, etc.), an emergency medicine advanced medical simulation scenario setup checklist, and other items of interest.

The American College of Emergency Physicians
http://www.acep.org/cme.asp-x?id=22382
The American College of Emergency Physicians (ACEP) offers a basic and advanced teaching fellowship for faculty that includes one of the only hands-on faculty development courses in the United States for simulation.

The Society for Technology in Anesthesia
http://www.anestech.org/home.htm
The Society for Technology in Anesthesia (STA) is an international organization of physicians, engineers, students and others with an interest in anesthesia-related technologies. STA's mission is to improve the quality of patient care by improving technology and its application. STA promotes education and research, collaborates with local, national, and international organizations, sponsors meetings and exhibitions, awards grants, and recognizes achievement. The journal, *Anesthesia & Analgesia* is STA's official publication. STA's quarterly newsletter, *Interface*, is available online.

Mededportal
www.aamc.org/mededportal
The Association of American Medical Colleges' MedEdPORTAL facilitates sharing of high quality peer-reviewed educational material and promotes collaboration and educational scholarships across institutions. Examples of MedEdPORTAL publications include tutorials,

virtual patients, cases, lab manuals, assessment instruments, faculty development materials, etc. for use by students, resident and practicing physicians. The MedEdPORTAL has indexed nearly 100 virtual patients (VPs), interactive programs that simulate real-life clinical scenarios. With VPs, learners can virtually experience a patient interview, perform many aspects of the physical examination, and even make diagnostic and therapeutic decisions.

Harvard-Mit Affiliated Center for Medical Simulation
http://www.harvardmedsim.org/
Harvard-MIT affiliated Center for Medical Simulation (CMS) offers a course to train faculty in using simulation. The course provides and a solid foundation in the underlying science of simulation.

Pulse!!
http://www.sp.tamucc.edu/pulse/home.asp
Pulse!!, a game-based platform, is designed as a cognitive, experiential learning tool for military and civilian health-care providers. This state-of-the-art simulator employs cutting-edge technologies to create a realistic, complex, high-fidelity virtual health-care lab. Multiple scenarios present clinically variant pathologies, patients, settings and emergencies in a controlled virtual environment. Pulse!! has a high-fidelity, computer-based learning platform designed to train physicians, medical students and allied personnel in virtual space at no risk to actual patients. Pulse!!, a collaboration of Texas A&M University-Corpus Christi and commercial game developer BreakAway, Ltd. of Hunt Valley, Maryland, began testing in January 2009 at Yale University School of Medicine in New Haven, Connecticut; The Johns Hopkins School of Medicine in Baltimore, Maryland; and the National Naval Medical Center in Bethesda, Maryland.

Duke University Human Simulation and Patient Safety Center
http://simcenter.duke.edu/projects/
The Human Simulation and Patient Safety Center at Duke University School of Medicine provides comprehensive resources for medical education. The Center has worked closely with a number of organizations, including a study for the National Board of Medical Examiners to evaluate assessment tools. The SimDot network allows simulation centers around the world to share high-fidelity simulation programming and didactics over the Internet. Specialty specific editorial boards have been named to peer review cases in the SimDot library, which will eventually encompass multiple specialties and support multiple simulators. The Center is also building an active medical human factors engineering program focused on patient safety. Sample protocols being developed include: (1) the effectiveness of simulation in the learning and retention of cardiovascular medical concepts; (2) the evaluation of new equipment displays; (3) the use of collaborative web environments in simulation development; and (4) the use of new forms of data representation in the operating room environment.

DISCUSSION

Most US allopathic and osteopathic medical schools routinely incorporate simulation as a standard part of their curriculum. Osteopathic colleges also have experiences an increased use of standardized patients and mechanical simulators from 2001 to 2005.[10] Current studies show that the use of medical simulation in GME has increased for a number of reasons, including the limitations of the 80-hour resident work week, patient dissatisfaction with being “practiced on,” a greater emphasis on patient safety, and the importance of early acquisition of complex clinical skills.[3]

In the past, simulations were not realistic, however, due to improvements and technology, realism has increased. Simulations have been shown to reduce human error in performing clinical procedures and provide a safe environment for doctors to learn such procedures without endangering real patients. Many forms of simulation are being used to teach the important skill of clinical decision-making as well as technical procedures.[11] Errors encountered during simulation can also be used to identify curriculum reform targets.[12]

Simulation is increasingly used as an effective method for teamwork training. As more accrediting bodies, both at the medical school and residency levels, move toward competency-based evaluation, the traditional roles of standardized patients pools are being expanded to include simulations involving other members of the health-care team and other people affected by the healthcare delivery system.

One example, the Basic Science of Care course at the University of Pittsburgh, School of Medicine, is targeted to second-year medical students and graduate level nursing students. The course is designed to teach students about health care systems, inter-professional care, and systems problems that arise in outpatient and inpatient settings when communication is absent or ineffective and strategic plans are not in place. These types of programs are feasible for both medical school and residency training, and they are consistent with the common program requirements of the Accreditation Council on Graduate Medical Education (ACGME) competencies (interpersonal and communication skills; systems-based practice).[13, 14]

Current studies show that patient simulator systems are effective training tools across all specialties. In a recent study, Gaca et al. concluded that simulation for radiology residents is as valuable to radiologists as it is to other clinical disciplines and that the use of simulation offers substantial promise as a training aid.[15] Lighthall reported the use of realistic clinical simulator systems can help to facilitate and standardize the training of critical-care physicians without having the training process jeopardize the well-being of critically-ill patients who depend on the integrated and efficient actions of providers with specialized training.[16]

Issenberg and Scalese noted that costs are often among the most significant challenges when implementing a simulation program. Sophisticated technologies, such as high-fidelity patient simulators can range from ~$30,000 to ~$250,000 for the initial purchase. Additional costs are incurred with operation, storage, maintenance, and updating simulation devices.[17]

Boulet et al. concluded that as simulation-based assessments are more broadly adopted, especially for high stakes competency decisions, designing and completing outcome studies that provide support for the validity of performance measures will be the most important next step.[6] Some suggest that specific simulated clinical scenarios should be adopted into the training curriculum; and other opportunities to enhance preparedness, remove risk from the patient bedside, and ensure the achievement of critical milestones should be explored.[17, 18]

RECOMMENDATIONS

Simulation holds significant promise for the training of medical students, resident physicians, and practicing physicians. The Council on Medical Education recommends that the following recommendations be adopted and that the remainder of the report be filed.

1. That our American Medical Association (AMA) continue to advocate for additional funding for research in curriculum development, pedagogy, and outcomes to further assess the

effectiveness of simulation and to implement effective approaches to the use of simulation in both teaching and assessment. (Directive to Take Action)

2. That our AMA continue to work with and review, at five-year intervals, the accreditation requirements of the Liaison Committee on Medical Education (LCME), the Accreditation Council for Graduate Medical Education (ACGME), and the Accreditation Council for Continuing Medical Education (ACCME) to assure that program requirements reflect appropriate use and assessment of simulation in education programs. (Directive to Take Action)

3. That our AMA encourage medical education institutions that do not have accessible resources for simulation-based teaching to use the resources available at off-site simulation centers, such as online simulated assessment tools and simulated program development assistance. (Directive to Take Action)

4. That our AMA monitor the use of simulation in high-stakes examinations administered for licensure and certification as the use of new simulation technology expands. (Directive to Take Action)

5. That our AMA further evaluate the appropriate use of simulation in interprofessional education and clinical team building. (Directive to Take Action)

6. That our AMA work with the LCME, the ACGME, and other stakeholder organizations and institutions to further identify appropriate uses for simulation resources in the medical curriculum. (Directive to Take Action)

7. Rescind Directive to Take Action (D-295.943), Uses of Simulation in Medical Education – to Simulate or not to Simulate? 1. Our AMA will (a) through its Council on Medical Education, monitor the developments in uses of simulation and simulators in physician preparation for entry and re-entry into clinical practice, and provide an update to the AMA House of Delegates at the 2009 Annual Meeting; and (b) disseminate the information in this report.

Fiscal Note: $4000 for research and data gathering.

AMA Policy

D-295.943 Uses of Simulation in Medical Education – to Simulate or not to Simulate?

Our AMA will: (a) through its Council on Medical Education, monitor the developments in uses of simulation and simulators in physician preparation for entry and re-entry into clinical practice, and provide an update to the AMA House of Delegates at the 2009 Annual Meeting; and (b) disseminate the information in this report. 2. Our AMA will advocate for additional funding for research to further assess the effectiveness of simulation and to implement the use of simulators for use in both teaching and assessment. 3. Our AMA will work with appropriate organizations and institutions to convene a meeting on the use of simulation in medical education.
(CME Rep. 15, A-07)

References

1. Issenberg SB, McCaghie WC, Petrusa ER, Gordon DL, et al. Features and uses of high-fidelity simulations that lead to effective learning: a BEME systematic review. Medical Teacher. 2005;27:10-28.
2. Use of Simulation in Medical Education. West Virginia University, School of Medicine. Available at: http://www.hsc.wvu.edu/development/som/priorities/simulation.asp (Accessed 2-23-09).
3. McLaughlin S, Fitch MT, Goyal DG, Hayden E, et al. Simulation in Graduate Medical Education 2008: A Review for Emergency Medicine. Acad Emerg Med. Nov 2008;15(11):1117-1128.
4. Boulet JR. Summative Assessment in Medicine: The Promise of Simulation for High-stakes Evaluation. Acad Emerg Med. Nov 2008;15(11):1017-1024.
5. Stefanidis D, Heniford BT. The formula for a successful laparoscopic skills curriculum. Arch Surg. 2009 Jan;144(1):77-82.
6. Boulet JR, Smee SM, Dillon GF, Gimpel JR. The Use of Standardized Patient Assessments for Certification and Licensure Decisions. Simul Healthc. 2009 Spring;4(1):35-42.
7. ABIM to use Medical Simulation Technology to Evaluate Physician Competence. American Board of Internal Medicine. Available at: http://www.abim.org/news/news/01-29-08-mst.aspx (Accessed 2-26-09).
8. Dillon GF, Clauser BE. Computer-Delivered Patient Simulations in the United States Medical Licensing Examination (USMLE). Simul Healthc. 2009 Spring;4(1):30-4.
9. The Visible Human Project. National Library of Medicine. Available at: http://www.nlm.nih.gov/research/visible/visible_human.html (Accessed 2-24-09).
10. Gimpel JR, Weidner AC, Boulet JR, Wilson C, Errichetti AM. Standardized patients and mechanical simulators in teaching and assessment at colleges of osteopathic medicine. J AM Osteopath Assoc. 2007;107:557-61.
11. McConnell H, Pardy A. Virtual patient simulation for prevention of medical error: beyond just technical upskilling. World Hosp Health Serv. 2008;44(3):36-9.
12. Shilkofski NA, Nelson KL, Hunt EA. Recognition and treatment of unstable supraventricular tachycardia by pediatric residents in a simulation scenario. Simul Healthc. 2008 Spring;3(1):4-9.
13. Standardized Patient Program. University of Pittsburgh, School of Medicine. Available at: http://www.omed.pitt.edu/standardized/ (Accessed 2-23-09).
14. Interpersonal and Communication Skills. Accreditation Council for Graduate Medical Education Educational Program—Competencies. Available at: http://www.acgme.org/acWebsite/navPages/commonpr_documents/IVA5d_EducationalProgram_ACGMECompetencies_IPCS_Explanation.pdf (Accessed 2-24-09).
15. Gaca AM, Lerner CB, Frush DP. The radiology perspective: needs and tools for management of life-threatening events. Pediatr Radiol. 2008 Nov;38 Suppl 4:S714-9.
16. Lighthall GK, Barr J. The Use of Clinical Simulation Systems to Train Critical Care Physicians. J Intensive Care Med. 2007;22(5):257-269.
17. Issenberg SB, Scalese RJ. Simulation in health care education. Perspect Biol Med. 2008 Winter;51(1):31-46
18. Becker GJ. Simulation and the Coming Transformation of Medical Education. Radiology. October 2007;245:7-9.