European Review for Medical and Pharmacological Sciences 2007; 11: 1-8

Is simulation based medicine training the future of clinical medicine?

J.G. MURPHY, F. CREMONINI, G.C. KANE, W. DUNN

Mayo Multidisciplinary Simulation Center, Mayo Clinic College of Medicine, Rochester, MN (USA)

Abstract. – The training of physician in the art and science of clinical medicine presents several challenges that are well suited to simulation based medical education (SBME). Modern patient centered medical education seeks to provide comprehensive "hands-on" clinical exposure for physicians in training, while simultaneously providing maximum individual patient comfort and safety. The ethical conundrum is obvious: direct patient contact is needed in order to educate the best clinical physicians and surgeons, but patients have an expectation to be treated and have surgery performed only by highly trained healthcare personnel. This is the kernel of the "medical educators dilemma". Simulation based medical education can partially solve "the medical educators dilemma" by providing realistic medical education in a safe, error tolerant environment with convenience and advantages over conventional "bedside" training but is it real medicine or make believe!

Key Words:

Simulation, Medical education, Training, Clinical skills.

Introduction

Simulation based medical education (SBME) is rapidly approaching the "tipping point" when it will have a significant impact on how we educate health care professionals from multiple professional disciplines and will span the range from undergraduate medical student education to the retraining of experienced mid career specialists in new interventional and surgical techniques and possibly ultimately to high stakes physician and surgeon competence certification and testing[1-6]. Modern medical simulation bridges the gamut of sophistication from the simple anatomic models of individual organs through complex computer based high-fidelity human simulators that accurately replicate anatomic and physiological parameters and allow interaction with medical learners in biologically reproducible and meaningful ways[7-11].

Why Simulation-Based Medical Education?

The growth of interest in SBME has been fueled largely by three factors, the most important of which is the realization that medical errors are both common in the healthcare environment and constitute a large potentially preventable cause of patient morbidity and mortality[12-14]. Error reduction in medicine is now a clinical imperative for all physicians. Secondly, patients are more educated and rightly demand the highest clinical competence of all their physicians. Finally, recent technological advances and reduction in cost in computer processor power, memory technologies and video processing now permit the accurate reproduction of simulated clinical events with sufficient fidelity to reproduce physiologically accurate clinical scenarios. SBME provides risk-free learning that can encompass many complex elements of critical and rare clinical scenarios.

The fundamental concept of medical care itself has evolved over the last decade from that of the sole practitioner to predominantly team-based integrated health care. This evolution brings a new set of problems as communication errors are now the single commonest cause of medical error in most sophisticated healthcare systems. SBME is particularly suited to medical team coaching, and development of communication skills among healthcare professionals.

All major high personal risk industries outside medicine, including the aviation, military and nuclear power industries, utilize simulation-based education to train adult learners, from emergency to combat scenarios. The rationale for SBME of physicians is also compelling: medical care is

Corresponding Author: Joseph G Murphy, MD; e-mail: Murphy.joseph@mayo.edu

frequently a high-risk interaction for patients, with medical errors often resulting from reproducible errors in judgment or technique. Additionally, many rare and critical clinical scenarios are frequently not seen by physicians in training.

Is Simulation Based Medical Education Valid as a Teaching Technique?

Increasing evidence of the efficacy of simulation based educational methodologies is available. Certain simulation-based modalities of medical education shorten the learning curve for physicians who subsequently learn on patients, and have proven benefit. The increasing utilization of simulation in the broad contexts of medical education holds great promise in new demonstrations of efficacy. Simulation modalities are widely viewed as having adequate face validity to justify adoption within intensive care and coronary care education.

What is Medical Simulation?

Simulation, as a mechanism for physician training in healthcare is commonly regarded as a relatively new concept. However, SBME considered very broadly has been used to educate generations of physicians and includes diverse range of techniques from role-playing actors and differential diagnosis clinical scenarios to cadaveric dissection and stored "classic disease" imaging studies. The key point is that all of the above techniques use a simulation of real patients by using something less vital, thereby offering opportunities for learning associated with zero patient risk.

In the training of medical professionals, typical SBME modalities include: computer-based mannequins, task trainers, immersive visualization environment systems, and standardized patients.

Computer-Based Mannequins

High fidelity computer controlled clinical mannequins have been commercially available for over a decade. These mannequins reproduce many of the features of critical life threatening illness but often have technical and hardware limitations falling short of ideal for optimal simulation of clinical reality. The forte of mannequin simulators is team training and development of crisis communication skills, in which chaos is created "on demand", and teams train toward increased functionality. In many ways medical simulators are analogous to the way pilots are trained in flight simulators.

Task Trainers

Task trainers are medical simulators that train healthcare providers specifically in psychomotor skills or cognitive-manual integration skills required for complex medical or surgical procedures. Many such simulators have been shown to shorten the learning curve of operators in various procedures, including endoscopy, interventional cardiology, laparoscopy, and urologic procedures[15-21].

Standardized Patients

Standardized patients, long been in use for training in medical undergraduate education, have been recently implemented as a mandatory *Objective Structured Clinical Examination* (OSCE) experience for all physicians undergoing licensure assessment in the United States. Actors assisting in simulating patient encounters can be utilized within critical care simulations, either as the patient or as "confederates", portraying family members, nurses, etc, thus facilitating realism and the "fog of war", a term initially coin by the famous Prussian general and military historian von Clausewitz (1780-1831) for the uncertainty in battle that also applies to medical uncertainties in critical medical situations.

What are the Unique Challenges of Clinical Education in the ICU/CCU Setting?

Patients in intensive care units (ICU) are by definition, sicker and generally hemodynamically and metabolically more tenuous than non-ICU patients. Equally the old medical principle that states that "the sicker the patients–the greater the possible impact and benefit of medical therapy" likely applies to most ICU patients. Thus clinical medicine presents simultaneously the opportunity to greatly improve the patient's health status but presents a relatively high risk of unintended adverse consequences. Medical trainees must at some stage examine and treat their first patient and ascend the "learning curve" of medical experience. All patients want "their" caregiver to be both competent and experienced yet individual patients are frequently unwilling to knowingly provide the early clinical experience that will lead to mature physician competence. No patient wants to be a surgeon's (or intensivist's or cardiologist's) first patient. The ethical dilemma is the obligation to provide the best patient care and insurance of patient safety while training medical learners in the art of clinical medicine and surgery. Ziv et al[7] characterized the ethical issue as follows "These conflicting needs create a fundamental ethical tension in medical education, one that is widely recognized although little discussed". Simulation based medical education has the potential to fill a unique role in ICU education by maximizing the educational experience while minimizing patients risk[22-28]. Exposure to rare clinical scenarios is currently haphazard: the trainee cares for and learns from the patients admitted to their clinical firm when they are on service irrespective of their personal training needs. Moreover, limitation of resident hours means that trainees run the risk of limited exposure to patients with rarer diseases and with unusual and complex disease pathophysiology.

What is Experiential Learning?

The education of clinical and cardiology trainees has long been potently experiential. All physicians typically recognize that the most potent learning of the training years typically occurs by the process of: (1) having a certain baseline knowledge, (2) caring for a difficult patient, and (3) vigorously pursuing the medical literature toward focused learning pertaining to the clinical *experience*. Such learning is then applied to subsequent patients, through such "practice" of medicine. Figure 1 describes this experiential learning cycle.

More simply, this can be viewed as the "brief → experience → debrief" cycle of learning widely practiced in aviation simulation.

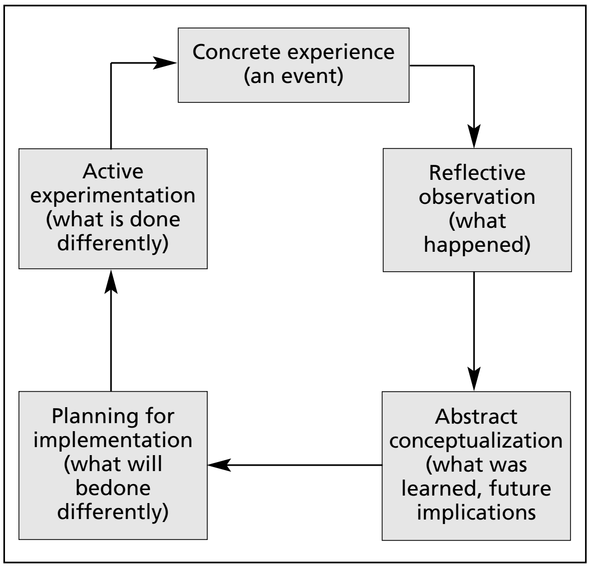

Figure 1. Flow of Experiential Learning. (Reflective thought and action).

The application of SBME within intensive and coronary care training contexts thus should be viewed with no more skepticism, if performed well, than experiential learning as has been known within medicine for centuries, within a more traditional apprentice model of training. The clear advantages of SBME lie within the predictability, curricular clarity, and absence of risk, in comparison to the traditional model of experiential learning, utilizing patients (Table I).

Within this process, information is received by the learner in sensory form (usually visual and/or auditory). This information is then processed along with the associated emotional content and encoded in the brain as a tangible memory and integrated into the neural structural, capable of efficient retrieval for use on subsequent patients (or simulations). The importance of experience in adult learning was first articulated by John Dewey, and still serves as a basis upon which much of current adult learning theory is understood, across all disciplines[29]. Use of adult learning theory, as has been recognized and utilized in disciplines outside clinical/coronary care medicine, is recognized to impact learning within this experiential realm of medical education (Table II).

Medical learning may mean different things to different educators. However, a widely recognized construct useful in creating SBME is that of Bloom's taxonomy of adult learning[30]. Bloom characterized the three domains of learning as cognitive, psychomotor, and affective. Traditional measures of cognition (e.g. multiple choice questions – MCQs) offer good analysis of cognitive learning. Educators recognize however that traditional modes of cognitive assessment offer little in valid assessments within the psychomotor or affective (i.e. attitudinal) domains. SBME offers the ability to evaluate and characterize (psychomotor) cognitive-manual integration skills, such as are required within the demonstrated competence concepts of difficult airway management. Additionally, affective domain functioning is demonstrable in simulations requiring human interaction, such as can occur within standardized patient or crisis resource management environments.

How Do Physicians Learn

Physicians engage daily in learning experiences both consciously and unconsciously, yet few actively consider the psychological process-

Table I. Advantages of simulation training over traditional medical training in clinical education.

1. Training to competence as objectively documented in a patient safe environment rather than training based primarily on apprenticeship time
2. "See one, simulate many, demonstrate competence, do one" rather than the traditional "see one, do one, teach one"
3. Absolutely safe environment for the "simulated patient"
4. Ability to objectively demonstrate simulator based competence before treating live patients
5. Safe environment for the student/physician learner to fail and learn from failure during training in invasive procedures
6. Ability to provide continuous medical education for practicing physicians in a non threatening and confidential manner
7. Ability to provide planned exposures to rare clinical scenarios
8. Avoidance of need for informed consent from the "simulated patient"
9. Ability to mix and match complicated clinical scenarios and provide training in management of information overload scenarios
10. The ability to plan training opportunities rather than waiting for a suitable live patients to arise clinically
11. The ability to provide immediate and objective feedback for reflective learning
12. The opportunity to repeat scenarios and develop per benchmarking performance criteria
13. The opportunity for team learning and leadership development
14. Assessment of competence based on objective metrics
15. Lower cost training through less use of expensive patients facilities such as catheterization laboratories or operating rooms
16. Potential lower cost through clinical error reduction and fewer malpractice insurance claims
17. Maximize resident and fellow training experience in an era of mandated maximum resident and fellow hours

es that underlie medical cognition or surgical dexterity proficiency. Learning is often broadly defined as "a change in behavior or understanding", but the factors that lead to changes in medical competence are poorly defined. Furthermore, it is widely recognized that lectures, a traditional form of medical education, are typically insufficient in modifying physician behavior, whereas experiential means of education demonstrably produce behavioral changes.

Medical education is considered a unique form of advanced learning by its practitioners, that uses a process of deductive reasoning, has need for manual dexterity and entails adverse consequences associated with poor performance and attitudinal perspectives. Educational psychologists study how learners receive, interpret, encode, store, and retrieve educational information and the optimal strategies by which educators should either impart or more commonly facilitate such learning. The effects of SBME on the cognitive process of medical learners and how this will translate to real world human problem solving, memory, and creativity is poorly understood. The common education psychology models of learning and how these might impact SBME are reviewed briefly below.

Formalized Learning

Task-Conscious or Acquisition Learning

Acquisition learning occurs all the time, particularly in clinical medicine. It is concrete, im-

Table II. Principles of adult learning

1. Adult learning programs should capitalize on the life experience of participants
2. Adult learning programs should adapt to the aging limitations of the participants
3. Adults should be challenged to move to increasingly advanced stages of personal development
4. Adults should have a wide choice in the availability and structural organization of learning programs

Table III. Hierarchy of simulation tools and approaches used in simulation-based medical education.

1. Basic Anatomic models and task trainers used to practice manipulative and dexterity skills
2. Professional or amateur actors trained to role-play patients, for training and assessment of physician patient interaction skills including, clinical history, physical examination techniques and communication skills
3. Computer programs used to simulate clinical scenarios with text and interactive case graphics used to assess clinical knowledge and decision making
4. The integration of actual medical devices and surgical instruments with computer simulation technology into virtual reality devices and simulators that replicate a clinical setting and allows haptic responses using high-fidelity visual, audio, touch cues., e.g., ultrasound, bronchoscopy, cardiology, laparoscopic surgery, arthroscopy, sigmoidoscopy, dentistry
5. Computer-integrated, full-length anatomic and physiologic mannequins that simulate high-risk clinical situations in realistic lifelike settings used in team trauma training

mediate and generally confined to a specific activity; it is not concerned with broad principles. In this type of learning the student is aware of the task at hand, but relatively unaware of the learning process. This type of learning comes under the rubric of clinical experience.

Principles of Simulation Based Medical Education

A basic principle in simulation education is that the more the student believes they are in the real situation (suspension of disbelief with associated strong face validity) the better will be the education experience. A hierarchy of medical education simulation trainers illustrates a growing trend towards complexity and deeper immersion of the student/learner in the simulated scenario (Table III). However the simulation experience by itself is not sufficient. To maximize its impact it must be accompanied by feedback and debriefing. This may be a face to face encounter with a clinical teacher or it may be a computer generated score and directed tutorial.

Experiential Learning

SBME is a specific method of experiential learning (Table IV). Education psychologists distinguish two broad types of learning namely cognitive learning (abstract) and experiential learning (concrete). Cognitive learning corresponds to academic knowledge such as the concept of brain receptor function while experiential learning refers to applying knowledge such as cardiac anatomy that directly facilitates performance of a specific skill such as cardiac catheterization. The key to the distinction is that experiential learning directly addresses the immediate specific needs of the learner: core characteristics of experiential learning are personal involvement, self-initiated and motivated learning, self evaluation and reflection by the learner, and the totality of the enveloping effect of the learning experience on the learner. Experiential education is based on the premise that human beings naturally want to learn, and that the role of the teacher is to facilitate such learning by setting a positive climate for learning, clarifying the goals of the learner and organizing the delivery of learning resources. Experiential learning is facilitated when the student participates completely in the learning process and has control over its nature and direction.

Error Reduction and Simulation

Being a patient in a hospital is a relatively high-risk undertaking. All patients run the gaunt-

Table IV. Principles of experiential learning.

1. B1. A key positive driver of significant experiential learning is when the subject matter is linked to the personal interests of the student
2. A key negative driver for experiential learning is learner perceived threats to their self esteem
3. Experiential learning proceeds faster when external threats are at a minimum and the learner has the opportunity to fail and learn from failure in a safe environment
4. Self-initiated experiential learning is deeply encoded in memory

let of hospital acquired infections, medication associated anaphylaxis and drug interactions in addition to their specific disease morbidity and mortality. In fact, on a crude daily risk basis entering hospital as a patient is more dangerous than joining the army, mountain climbing or parachuting. The safety and error-prevention record of industries that are generally considered high risk such as aviation, chemical manufacturing, and nuclear power plants compare very favorably with the untoward incident event rate of hospitals. The reasons for this are complex but include many issues related to worker education. These include: the promotion of a safety culture that emphasizes teamwork rather than individual strengths, lessons learned from crew resource management, best safety practices, the overriding commitment of management to safety, and non-punitive and simplified reporting of errors with feedback of error root cause analyses. Many would argue that healthcare is behind other high-risk industries in this regard. The safe management of the acutely ill patient presents particular difficulties as the causes of errors are diverse, often complex, and rarely attributable to a single action, event, or individual. Medical errors are often rooted in unsafe systems rather than individual caregivers. The final common pathway, however, is the interaction between practitioner and patient.

This physician-patients relationship has changed from the historic model in which the physician was paternalistic and compassionate, but endowed with therapies often of limited therapeutic benefit to the current physician-patient relationship, which is more equitable, less paternalistic, more transparent, more team-based, and regrettably more business orientated and contractual. Treatments in general have become more effective with a correspondingly greater capacity to harm if misused. The consequences of a misdiagnosis are now more profound than in the past as the opportunity for disease cure may be lost.

Clinical trainees like all physicians occasionally make errors with some errors likely based in inexperience. This is accepted and ethically rationalized on the presumption that senior faculty will detect junior physician errors at a point where no significant patient harm has occurred. In a simulated medical environment learning from errors is a key component of experiential learning and errors can be allowed to progress to a simulated bad outcome as a means to teach the trainee the implications of the error and how it can be detected, prevented and rectified. Judgment errors and failures of technique also occur among senior physicians and surgeons. Confidential simulation based objective assessment of competence is a valuable and possibly less threatening means of continuing medical education and recertification for many senior medical personnel. The validity and reliability of this is under investigation by many researchers. The model of "high stakes" proficiency testing throughout an individual's career by means of simulators already exists in aviation and will likely follow in medicine. A series of simulation experiences are already part of the board certification process for anesthesiology in Israel. It is likely that many medical mistakes committed by physicians in training are never detected or admitted. It is human nature to deny causation, discounting personal responsibility, or in one way or another distancing oneself from an untoward clinical consequences. This in turn leads to a worse situation in which systemic errors (mistakes that are literally invited by the system) are not surfaced and investigated. Suboptimal performance made during simulation may allow detection of systematic errors before harm has occurred to real patients. In addition performance deficits during SBME can be assessed in a non-threatening environment and reviewed as to causation without fear of disciplinary procedures or malpractice litigation.

Limitations to Simulation Based Medical Education

The greatest limitations to the widespread use of medical simulator technology are cost and the absence of carefully controlled validation studies for many simulation techniques. While SBME promises to be a valuable instructional and evaluative tool in clinical medicine there are several limitations to the methodology. Medical simulation works best as part of a structured curriculum with pre-defined learning objectives and an "after-action" debriefing session. Poorly defined medical "gaming scenarios" are generally of poor education value. It cannot be stressed enough that medical simulation will only fulfill its potential if implemented as part of a larger structured medical education program.

Many clinicians see excessive reliance on purely technological medicine as a threat to humanistic care. Medical educators who use SBME stress the humanistic, cultural and ethical dimensions of the practice of clinical medicine and use simulation technology to enhance rather than detract from humanistic training in medicine. Simulation scenarios should utilize simulated patients of diverse backgrounds without racial or gender stereotyping.

The development of realistic clinical scenarios is time-consuming for faculty and expensive for institutions. Validation of the educational objectives and benefits to learners are frequently lacking for many SBME tools. Validation of SBME as a means of high stakes testing for practicing physicians will require years of comprehensive study and will likely engender strong emotions from physicians. However ultimately it is likely that medicine will follow in the path of the aviation industry, where credentialing and competence assessment of pilots, based on flight simulators, is considered the routine exercise. Realistic and reproducible medical scenarios need clinical validation to ensure they adequately reproduce key clinical learning objectives and are fair and reliable measures of clinical competence. There are technical limitations in the fidelity of medical simulators, particularly for a generation of learners that have the expectations of a simulation experience based on modestly priced but incredibly high fidelity commercial game machines currently on the market.

In conclusion, clinical patient simulation technology has evolved rapidly over the past twenty years such that the current generation of patient simulators have numerous advanced clinical scenarios that can be programmed to create a structured, clinically realistic, and safe learning environment. The optimal integration of SBME into medical student, resident and fellow education requires further study to validate and optimize the learning experience and develop objective criteria by which physician performance on patient simulators can assessed and translated to better patients care. Finally, simulation is meant to complement, not replace, direct bedside clinical instruction. The development of humanistic qualities and patient compassion in young physicians are central tenets of our profession which will always require instruction and cultivation by senior physician mentors and which will never adequately be simulated by technology, no matter how sophisticated. Simulation based education will enhance, not detract from the role of the physician clinical educator.

References

1) Bion J, Heffner J. Challenges in the care of the acutely ill. Lancet 2004; 363: 941: 970-977.

2) Wong N. Medical education in critical care. J Crit Care 2005; 20: 270-273.

3) Good ML. Patient simulation for training basic and advanced clinical skills. Med Educ 2003; 37(Suppl 1): 14-21.

4) O. Brien G, Haughton A, Flanagan B. Interns' perceptions of performance and confidence in participating in and managing simulated and real cardiac arrest situations. Med Teach 2001; 23: 389-395.

5) Grenvik A, Schaefer JJ 3rd, DeVita MA, Rogers P. New aspects on critical care medicine training. Curr Opin Crit Care 2004; 10: 233-237.

6) Moorthy K, Vincent C, Darzi A. Simulation based training. Br Med J 2005; 330(7490): 493-494.

7) Ziv A, Wolpe PR, Small SD, Glick S. Simulation-based medical education: an ethical imperative. Acad Med 2003; 78: 783-788.

8) Lighthall GK, Barr J, Howard SK, Gellar E, Sowb Y, Bertacini E, Gaba D. Use of a fully simulated clinical unit environment for critical event management training for internal medicine residents. Crit Care Med 2003; 31: 2437-2443.

9) Schwid H, Rooke G, Ross B, Sivarajan M. Use of a computerized advanced cardiac life support simulator improves retention of advanced cardiac life support guidelines better than a textbook review. Crit Care Med 1999; 27: 821-824.

10) Issenberg SB, Petrusa ER, McGaghie WC, Felner JM, Waugh RA, Nash IS, Hart IR. Effectiveness of a computer-based system to teach bedside cardiology. Acad Med 1999; 74(10 Suppl): S93-S95.

11) Ziv A, Small SD, Wolpe PR. Patient safety and simulation-based medical education. Med Teacher 2000; 22: 489-495.

12) Kohn, L, Corrigan J, Donaldson M (eds). To Err is Human: Building a Safer Health System. Committee on Quality in America. Institute of Medicine, Washington, DC: National Academy Press, 1999.

13) Berwick DM, Leape LL. Reducing errors in medicine. Br Med J 1999; 319: 136-137.

14) Leape LL. Errors in medicine. JAMA 1994; 272: 1851-1857.

15) Korndorffer JR Jr, Dunne JB, Sierra R, Stefanidis D, Touchard CL, Scott DJ. Simulator training for laparoscopic suturing using performance goals translates to the operating room. J Am Coll Surg 2005; 201: 23-29.

16) Brunner WC, Korndorffer JR Jr, Sierra R, Dunne JB, Yau CL, Corsetti RL, Slakey DP, Townsend MC, Scott DJ. Determining standards for laparoscopic proficiency using virtual reality. Am J Surg 2005; 71: 29-35.

17) Gallagher AG, Lederman AB, McGlade K, Satava RM, Smith CD. Discriminative validity of the Minimally Invasive Surgical Trainer in Virtual Reality (MIST-VR) using criteria levels based on expert performance. Surg Endosc 2004; 18: 660-665.

18) Arora H, Uribe J, Ralph W, Zeltsan M, Cuellar H, Gallagher A, Fried MP. Assessment of construct validity of the endoscopic sinus surgery simulator. Arch Otolaryngol Head Neck Surg 2005; 131: 217-221.

19) Ost D, DeRosiers A, Britt EJ, Fein AM, Lesser ML, Mehta AC. Assessment of a bronchoscopy simulator. Am J Respir Crit Care Med 2001; 164: 2248-2255.

20) Gordon JA, Oriol NE, Cooper JB. Bringing good teaching cases “to life”: a simulator-based medical education service. Acad Med 2004; 79: 23-27.

21) Sedlack RE, Kolars JC. Computer simulator training enhances the competency of gastroenterology fellows at colonoscopy: results of a pilot study. Am J Gastroenterol 2004; 99: 33-37.

22) Lighthall GK, Barr J, Howard SK, Gellar E, Sowb Y, Bertacini E, Gaba D. Use of a fully simulated intensive care unit environment for critical event management training for internal medicine residents. Crit Care Med 2003; 31: 2437-2443.

23) Davis D, O'Brien MA, Freemantle N, Wolf FM, Mazmanian P, Taylor-Vaisey A. Impact of formal continuing medical education: do conferences, workshops, rounds, and other traditional continuing education activities change physician behavior or health care outcomes? JAMA 1999; 282: 867-874.

24) Gaba DM, Howard SK, Flanagan B, Smith BE, Fish KJ, Botney R. Assessment of clinical performance during simulated crises using both technical and behavioral ratings. Anesthesiology 1998; 89: 8-18.

25) Mayo PH, Hackney JE, Mueck JT, Ribaudo V, Schneider RF. Achieving house staff competence in emergency airway management: results of a teaching program using a computerized patient simulator. Crit Care Med 2004; 32: 2422-2427.

26) Dunn WF. Education theory applied to critical care: Dewey versus tradition: it really does matter. Am J Respir Crit Care Med 2003; 167: 4-5.

27) Howard SK, Gaba DM, Fish KJ, Yang G, Sarnquist FH. Anesthesia crisis resource management training: teaching anesthesiologists to handle critical incidents. Aviat Space Environ Med 1992; 63: 763-770.

28) Muller ES, Harik P, Margolis M, Clauser B, McKinley D, Boulet Jr. An examination of the relationship between clinical skills examination performance and performance on USMLE Step 2. Acad Med 2003; 78(10 Suppl): S27-29.

29) Dewey, John. In: Democracy and education. An introduction to the philosophy of education.The Macmillan Company, 1916. [http://www.ilt.columbia.edu/publications/ dewey.html].

30) Bloom BS. Effects of continuing medical education on improving physician clinical care and patient health: a review of systematic reviews. Int J Technol Assess Health Care 2005; 21: 380-385.