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Title: Simulation in Emergency Medicine Training

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Abstract

Simulation provides a range of educational tools which have increasingly been incorporated into emergency medicine (EM) curricula. Standardized patients and some partial task trainers, such as intubation heads, and have been used for decades. More recently, a growing number of computer screen simulations, high-fidelity mannequins, and virtual reality simulators have expanded the number of procedures and conditions which can be effectively simulated.

The Accreditation Council for Graduate Medical Education transitioned to a competency-based assessment of residency programs in 2001 and included simulation as one method for incorporating the six core competencies into graduate medical education curricula. Over the past decade, numerous peer reviewed publications have promoted simulation as an effective educational tool for each of the core competencies.

The advanced technology used to operate many current simulators can erroneously become the focus of efforts to create a simulation-based curriculum. Simulation can most effectively be incorporated into EM curricula through the use of time-proven concepts which start with defining the targeted learners, assessing their general and specific educational needs, defining learning objectives, and selecting the best educational strategy for achieving each

objective. In many, but not all, instances simulation can be the best tool for achieving EM learning objectives.

Introduction

Coach Vince Lombardi coined the phrase “practice doesn’t make perfect, perfect practice makes perfect”.[1] This sage advice for achieving skill mastery applies to many disciplines including the mastery of clinical skills. Over the past decade, emergency medicine educators quickly embraced simulation as an innovation in medical education which helps create ‘perfect practice’ environments. Emergency medicine (EM) leaders have fostered interest in simulation as an educational tool. In 2004, members of the Educational Technology Section of the Academic Emergency Medicine (AEM) Consensus Conference for Informatics and Technology in Emergency Department Health Care developed consensus statements addressing the use of simulation in emergency medicine training.[2] The following year, the Society for Academic Emergency Medicine (SAEM) created a Simulation Task Force.[3] The 2008 AEM Consensus Conference, "The Science of Simulation in Healthcare: Defining and Developing Clinical Expertise," focused on the use of simulation for the development of individual expertise in EM[4] and in 2009 SAEM created a Simulation Academy from the Task Force in response to growing interest in EM simulation training. Age-appropriate models and simulation-based pediatric emergency medicine curricula have helped address the specific needs of pediatric EM training in a variety of environments.[5,6] The Accreditation Council for Graduate Medical Education (ACGME) further verified simulation’s role in EM education by including it as an instrument for resident assessment in the Toolbox of Assessment Methods©.[7] Similarly, the Residency Review Committee in Emergency Medicine (RRC-EM) incorporated simulation as a tool for assessing resident competency in both critical patient resuscitation and evaluation of key emergency medicine chief complaints.[8]

Spectrum of Simulation Modalities

Emergency Medicine educators have used simulation as a teaching tool for decades. Simulation models such as intubation heads and cardiopulmonary resuscitation mannequins have been an essential part of key training programs including basic life support, advanced cardiac life support, and pediatric advanced life support. More recently, manufacturers have engineered advanced technology into large-scale production of simulators capable of modeling a wider variety of clinical scenarios which educators can incorporate in EM training curricula. Based on the defined learning objectives established for a targeted student population, instructors can select the best method of instruction which may include one of the following simulation tools.

Standardized patients

The strength of standardized patients in simulation is the degree of interaction they can have with students, and the full complement of primarily normal physical findings or isolated, fixed, abnormal findings (e.g., murmurs, ophthalmologic findings, and ascites) they provide for students to examine. However, they are not suitable for scenarios requiring patients with abnormal physiology or in which students perform more-than-minimal risk procedures. Consequently, educators extensively use standardized patients to train and test basic skills such as history taking and physical examination as well as for simulations which focus on communication skills and professionalism at multiple levels of clinical development.[9-12] Pediatric emergency training has successfully incorporated child actors playing the patient's role[13,14] as well as adult standardized patients playing parental roles in simulations focused on trainee communication skills such as the delivery of bad news.[15]

Partial task trainers

A partial task trainer is frequently the ideal tool when the learning objective is confidence and/or competence in an emergency procedure. Current technology has increased the number and the variety of simulated procedures, but the task and not the technology is the key factor. The simulator can be as simple as an orange for injection training or as complex as a virtual reality ultrasonography model. Partial task trainers have been successfully used to teach clinical pharmacology,[16] airway management,[17] cardiovascular examination findings,[18] surgical cricothyroidotomy,[19] central-line catherization,[20,21] epistaxis management,[22,23] and a variety of pediatric emergency procedures.[24]

Medical educators predominantly use virtual-reality partial task trainers for surgical simulations. However, a number of models can augment training in emergency procedures including pericardiocentesis, cricothyroidotomy, resuscitative thoracotomy,[25] fiberoptic intubation,[26] and intravenous catherization.[27] In addition to auditory and visual feedback, these systems frequently provide the user with additional information using the sense of touch. This haptic feedback delivers an added dimension of reality as the operator senses appropriate degrees of resistance while performing each procedure.

Wang et al. reviewed the literature addressing simulation-based task training for EM residents focusing on procedures identified as critical by the RRC-EM. The authors recommended utilizing simulation to practice infrequently encountered procedures and those which pose a significant patient risk when performed by an inexperienced provider.[28] In order to confirm the value of current task training efforts, they also identified the need for future research to demonstrate the validity and reliability of simulations for airway management, central venous catheterization, cricothyroidotomy, tube thoracostomy, cardiac pacing, pericardiocentesis, ultrasound exams, vaginal delivery, and lumbar puncture.

High-fidelity mannequins

The literature contains a number of terms for this modality, the most frequent of which are human patient simulators, high-fidelity simulators, and high-fidelity patient simulators. Although there are no strict definitions, these terms generally apply to full-body simulators with remote computerized controls, monitor displays of vital signs, and air-compressor driven functions creating both normal physiology (e.g., pulses and breathing) and pathophysiologic processes (e.g., tongue swelling and trismus). The capabilities of these devices have increased significantly over the past several years, making them particularly well suited for emergency medicine case-based scenario training. They lack the degree of reality and range of responses of a standardized patient, but their strength lies in the ability to present wide variations in physiologic parameters and to be repeatedly subjected to invasive procedures. Although many of the procedures overlap with those available in partial task trainers, high-fidelity mannequin case-based scenarios provide a better training platform for decision-making regarding when to perform a procedure and how to integrate it into the overall evaluation and treatment of each patient.

The last several years have witnessed a rapid growth of high-fidelity simulation training in EM residency programs. A 2003 survey of all accredited allopathic and osteopathic EM residencies (73% response) found 47% had high-fidelity mannequin-based simulation at their institution. Twenty-eight percent of the programs used the simulators and 9% of the EM training programs owned the simulators. Of the user group, 8% used the simulators every 1-2 weeks, 42% used them every 1-4 months, 24% used them yearly, and 26% used them "not regularly."[29] A follow-up survey in 2008 (75% response rate) revealed EM programs using high-fidelity mannequin simulators increased to 85%. Program ownership of the simulators increased to 43%, and 43% of programs reported the average resident use was greater than 10 hours a year.[30] Faculty time constraints and lack of faculty training were the largest barriers to utilization reported in the survey.

Students completing simulations with high-fidelity mannequins rated the interactive voice, palpable pulses, chest rise, and monitor display of vital signs as particularly useful in helping to achieve specified learning objectives. They rated prerecorded voices, an IV arm, heart tones, and abnormal breath sounds as less valuable.[31] Overall, multiple studies demonstrate students at all levels of training prefer high-fidelity simulation over less interactive teaching methods.[32-44]

Although high-fidelity simulation supports multiple facets of EM training including emergency department (ED) team training,[35,45-50] assessment of educational interventions or care processes,[39,51-57] and individual student assessment,[38,58] it is predominantly used as a tool for teaching individual clinical skills. Most studies evaluating the effectiveness of high-fidelity simulation as a teaching tool for clinical skills revealed increased student satisfaction with the training,[29,34-43,59-61] increased self-efficacy,[37,39,43,61,62] improved test performance[37,40,63,64] or improved performance during subsequent simulations.[42,45,62]

A few studies have addressed the impact of simulation-based training on performance during patient care. Davis et al. demonstrated an overall improvement in endotracheal intubation success rates and a significant decrease in hypoxic arrests during rapid-sequence intubation after initiating a simulation-based difficult-airway curriculum for air medical crews.[65] Rosenthal and colleagues demonstrated a statistically significant improvement in airway management skills in the laboratory with comparably high levels of performance in actual clinical settings following simulation-based training.[66] Similarly, paramedic students trained using scenarios on a high-fidelity simulator performed equally well in completing operating room (OR) intubation compared to students trained on live patients in the OR.[67] Wayne et al. found residents trained with a simulation-based curriculum achieved a significantly higher rate of adherence to advanced cardiac life support (ACLS) standards during in-hospital cardiac arrests compared to residents receiving ACLS training with a traditional curriculum.[68]

The pediatric emergency medicine simulation literature exhibits the same trends. Most published studies evaluated simulation as a teaching modality with endpoints other than improvements in actual clinical outcomes,[5,69-72] but a few studies illustrated improved performance in the clinical setting. Augarten et al. demonstrated improved management of patient pain and anxiety in a pediatric ED following a simulation-based formal teaching program.[73] Shavit et al. demonstrated enhanced safety practices by pediatric emergency physicians and pediatric gastroenterologists in the delivery of patient care following completion of a simulation-based sedation safety course.[74]

High-fidelity simulation has also provided educators with a useful tool for assessment of both clinical performance and the effectiveness of educational tools/interventions in pediatric emergency medicine. Brett-Fleegler et al. demonstrated good inter-rater reliability with preliminary construct validity for a pediatric resuscitation assessment tool evaluated in a series of high-fidelity simulations.[75] In another study evaluating 16 pediatric residents, Overly and colleagues concluded high-fidelity simulation was an effective modality for assessment of resident acute airway management skills. The high failure rate and significant number of harmful actions detected by the authors helped define the needs of the target learners and guide modifications in their curriculum.[76] Frush et al. evaluated the impact of a web-based training program on the proper use of the Broselow tape during a subsequent simulated case. They found a significantly lower rate of deviations from proper dosing and shorter time to dose delivery in the trained group of pediatric emergency providers compared to the control group.[77]

Looking to the future, Bond et al. developed a list of key high-fidelity simulation research topics focusing on the development of individual cognitive expertise in EM.[78] As a deliverable of the 2008 AEM Consensus Conference, their publication identified the following needs: creating benchmarks from studying experts; achieving competence in less time; optimizing simulation teaching strategies; matching the optimal characteristics of simulation to various learning objectives; using simulation as a remediation tool; and demonstrating the transfer of learning from simulation to patient care.

Two-dimensional computer-screen simulations

The 2004 AEM Consensus Conference for Informatics and Technology in Emergency Department Health Care concluded that all EDs should have access to computer-based systems for point-of-service information, medical education, and training.[2] Computer-based training is logistically simpler and in some instances is as effective as more expensive forms of simulation. Youngblood et al. found comparable improvements in ED crisis management and team leadership skills following online computer-based simulation training and training with a high-fidelity simulator.[79] Additional successful applications of two-dimensional computer simulations for emergency medicine curricula include team training[80,81] asthma management,[82] medical student trauma training,[83] proper utilization of the Broselow tape,[77] and training for independent raters evaluating resident performance during simulated invasive procedures.[84]

System-based simulations

The majority of system-based simulations focus on disaster response. Reported exercises address both hospital[85,86] and prehospital[87-90] events including airport,[89] radiologic dispersal device (dirty bomb),[90] and chemical weapon scenarios.[88] Kobayashi et al. proposed a model to incorporate high-fidelity simulation into mass-casualty training in order to enhance current multisystem training with comprehensive clinical management of selected victims during an exercise.[91] Investigators at Brown University effectively used in-situ simulations to evaluate EM processes including the clinical function of a new ED prior to opening for actual patient care.[52]

The 2008 AEM Consensus Conference subgroup addressing the rational application of simulation to EM microsystems identified additional system-based simulation applications.[92]

Hybrid simulations

Emergency medicine educators can expand the limits of any single simulation tool by combining two or more models to create hybrid simulations. Overly et al. employed standardized patients along with high-fidelity mannequins to teach an approach to difficult discussions in pediatric EM including child abuse, medication error, and sudden infant death.[93] McLaughlin and his co-investigators assessed EM residents' competence in performing sexual assault exams by combining an interview of a standardized patient with evidence collection from a mannequin.[94] Girzadas et al. enhanced their ectopic pregnancy simulation using a hybrid set-up incorporating a high-fidelity mannequin and an endovaginal ultrasound task trainer. Both the residents and the faculty evaluators rated the hybrid simulation significantly higher as an educational activity compared to a high-fidelity simulator with pictures of ultrasound images.[95]

Integration of simulation in emergency medicine training

Initiation of the Outcome Project by the ACGME in 2001 shifted the paradigm for residency program assessment from process to outcome.[96] The ACGME identified six core competencies in 1999 to provide the structure for outcome assessment. In 2002, the Council of Emergency Medicine Residency Directors developed EM-specific ACGME core competencies and identified various methods, including simulation; to integrate the competencies into the EM curriculum.[97] A consensus of major EM organizations adopted The Model of Clinical Practice of Emergency Medicine[98] (The Model) in 2003 and the Emergency Medicine Competency Taskforce, commissioned by the RRC-EM in 2004, incorporated the core competencies into The Model.[99] The following sections review some of the applications of simulation as a tool to teach or assess each of the six core competencies in EM training.

Patient Care

Much of the EM simulation literature addresses teaching and assessment of the patient care core competency for both adult[17,19-22,26,27,68,82,95,100-106] and pediatric[5,69,72,75,76, 107-112] patients. Simulation readily accommodates the focused, repetitive practice of desired patient care skills and behaviors. This key component of deliberate practice, as defined by Ericsson, strongly enhances the role of simulation as a training tool for the patient care competency and helps to create a 'perfect practice' environment.[113] McGaghie identified nine factors which provide a foundation for deliberate practice in simulation-based EM education and support its role in achieving and sustaining mastery in EM patient care.[114] The essential components of his model include challenging well motivated learners with repetitive practice of skills characterized by clear learning objectives, an appropriate level of difficulty, and rigorous educational measurements. Both the instructors and the students themselves must closely monitor performance, provide feedback, and evaluate progress relative to a mastery standard prior to advancing to another task.

Medical Knowledge

Simulation is an effective tool for increasing medical knowledge in providers.[62-64,111] However, it is not always the most efficient method of addressing issues limited to the medical knowledge competency. The main advantage of simulation compared with less interactive methods of instruction is the concurrent learning that occurs in other competencies while addressing medical knowledge issues as well as the additional knowledge gaps which the simulation may expose. For example, reading or lecture may be the preferred educational tool if the sole learning objective is to list the life threatening causes of chest pain. However, if the lesson includes additional learning objectives, a chest pain simulation scenario can be used. In addition to achieving the initial learning objective, the simulation provides students with an opportunity to assess a patient presenting with chest pain, order diagnostic tests, decide the likely cause, initiate therapy, reassess, manage a team, perform procedures, and make an appropriate disposition. During these additional activities, the instructors may uncover further knowledge gaps which they can address in the debriefing.

Practice-Based Learning and Improvement

Simulation can help fulfill the EM training requirement for practice-based improvement derived from systemic analysis of practice experience.[99] The student reflection and debriefing which follow a simulated patient encounter are key components of any simulation-based exercise. Debriefing is when students reflect on what they have experienced in order to incorporate it into meaningful learning.[115] Based on evidence drawn from over 3000 debriefings, Rudolph et al. developed a four-step model to employ debriefing in EM training as a formative assessment tool following simulation sessions. Their model includes: 1) observe student performance to find gaps between the desired and actual performance; 2) provide feedback based on the observed gaps; 3) explore the genesis of the performance gap; and 4) help close the gap with discussion and didactics.[116]

Instructor control of most variables is an additional advantage of simulation as a tool for practice-based learning and improvement. Unlike a preceptor in the ED, the instructor in a simulation has complete control over the patient's presentation, the underlying pathology, and the creation of learning opportunities for each case. Numerous studies have demonstrated the ability of simulation to detect practice-based improvement opportunities and the positive impact simulation has on making needed improvements in both adult[36,39,42,46,65,66,117-119] and pediatric[14,111,112,120] emergency practices. For example, Vozenilek et al. incorporated a high-fidelity simulator into morbidity and mortality conference to re-create patient encounters and provide a critical practice-based learning experience for their whole resident class.[121]

Interpersonal and Communication Skills

Simulation is ideally suited to assist trainees in their development of interpersonal and communication skills as well as to assess their mastery of these skills. The emergency department is a hectic environment. Trainees frequently use these skills when a preceptor is not at the bedside or is not able to provide immediate feedback. Consequently, in the clinical setting, preceptors don't always address lesser offenses in this area in a timely manner. In the simulation environment, this competency can be the focus of the session. The simulation instructor can incorporate all of the distractions existing in the real clinical environment, but during the simulation the instructor can be stop the action, address the performance, and the student can repeat the scenario without sacrificing the quality of care to an actual patient. Medical educators have effectively used simulation for needs assessment in this competency[12,49] and to improve performance in providers working with both adult[9,10,45] and pediatric[15,93,112] populations.

Professionalism

Gisondi et al. assessed EM resident professionalism using their response to ethical dilemmas during high-fidelity simulations.[122] Overly et al. included a medication error case in a series of three simulations designed to teach difficult discussion skills to pediatric EM providers, thus incorporating both the communication competency and the professionalism competency in one case.[93] Emergency medicine educators have traditionally used role-playing to teach ethics.[122,123] Simulation enhances role playing by providing a realistic patient encounter incorporating a credible ethical problem which must be addressed by trainees during an episode of care.

Systems-Based Practice

Educators can create simulated clinical scenarios in which trainees are challenged with system-based issues in the midst of multiple distracting events reflecting the way they occur during actual patient care. Wang and Vozenilek published a simulation-based curriculum focused on system-based practice core competency issues specific to EM.[124] Weinstock et al. effectively constructed and deployed a mobile simulation cart to move high-fidelity simulation out of the lab and into various locations within the actual work environment to help evaluate system errors encountered during the care of pediatric emergencies.[125]

Curriculum development

In 1997, Cavanaugh reviewed over three decades of medical simulation research and provided an overview of clinical teaching and testing applications for simulation technology.[126] McLaughlin et al. subsequently published a proposed three-year curriculum employing human patient simulators to teach the ACGME core competencies to EM residents.[127] Binstadt and colleagues[128] accomplished the formidable task of implementing a complete curriculum redesign for the Harvard EM residency which fully integrated simulation with The Model. Whether taking this comprehensive approach to revamp a complete curriculum or incorporating simulation into a portion of an existing curriculum, educators should first define their curricular needs and then match those needs to the available technology. Kern et al. published a six-step process for medical education curriculum development which provides a good construct for the discussion of EM simulation curriculum development.[129]

Step 1 - Problem identification and general needs assessment

Curriculum development starts with identifying the population of trainees and assessing their general educational needs. On a global scale, the ACGME core competencies, the RRC-EM requirements, and The Model drive EM residency training requirements. Individual residency programs and trainees in other than a residency training setting require specific problem identification and curricular needs assessment. For example, Treloar et al. created a simulation-based curriculum for Navy emergency medical personnel in an isolated location to address the identified problem of emergency skills degradation resulting from infrequent opportunities to utilize the skills.[103] They assessed the general training needs of the physician and technician trainees from a list of low-frequency, high-risk medical/surgical emergencies and demonstrated a significant improvement in post-training self-efficacy and preparedness. In a similar manner, Adler et al. developed a simulation-based curriculum of pediatric emergencies for EM residents by convening a panel of education and pediatric EM experts to assess the general curricular needs of the residents.[5]

Step 2 - Needs assessment of targeted learners

EM educators can assess the specific needs of an identified target group through informal discussion, formal interviews, surveys, tests, or direct observation. Residents are a key target learner group in the ED. Most studies have assessed resident training needs through direct observation during real or simulated patient care. For example, Barsuk et al. assessed the training needs of their targeted group of EM and internal medicine residents at Northwestern Memorial University Hospital based on a nationwide problem with infections attributed to central venous line placement.[20] They evaluated infection rates at their institution and validated the need for additional resident training. Following a simulation-based educational intervention, the authors demonstrated a significant decrease in the infection rate compared to a control group receiving traditional training. Similarly, faculty have demonstrated resident training needs in cardiac resuscitation,[109,130,131] pediatric airway management,[76] and other emergency competencies[122,132] in their respective institutions.

Step 3 - Goals and objectives

Learning objectives should be specific and measurable. These objectives can be cognitive, affective or psychomotor, and should follow a format defining time frame, target learner, desired knowledge/skill/attitude, and number of repetitions[129] (e.g., by the end of the clerkship the student will have demonstrated, at least once, the proper protocol for defibrillating a simulated patient in ventricular fibrillation). Rosen et al. refined the process of developing learning objectives for simulation training by employing an event-based approach for EM resident teamwork competencies which directly links the scenario events to the competencies being trained.[133]

Step 4 - Educational strategies

Strategies must address both curricular content and instructional methods. Curriculum planners should derive the content directly from the learning objectives developed in step 3, and the methods chosen must be congruent with the learning objectives being addressed. For example, students will have difficulty developing proficiency in a procedure if the material is only presented in a lecture format. However, relying solely on simulated experiences to help students learn a list of facts it is not very efficient. Simulation provides a methodology which realistically recreates a variety of findings from the real environment, including auditory, visual, and tactile cues and is most likely to be a beneficial strategy when these multiple cues are needed to achieve particular learning objectives. [134] The Harvard EM faculty exemplified the principle of matching objectives and strategies by using a consensus panel of experts to link the learning objectives they derived from The Model to the optimal teaching method from a menu of choices including small group discussion, large group lecture, clinical instruction in the ED, self-study, computer simulation lab, task-training, and high-fidelity simulation.[128] Other programs can evaluate their results or utilize a similar process on a smaller scale to select educational strategies.

Step 5 - Implementation

Implementation of a simulation-based curriculum involves more than the actual performance of the simulated case or skill. Successful implementation includes: 1) preparation of an appropriate simulation script, which will elicit the behaviors outlined in the learning objectives; 2) time for deliberate practice; and 3) a comprehensive debriefing to allow reflection, reinforce correct behaviors, and correct erroneous actions.

In a 2005 systematic review of high-fidelity medical simulations, Issenberg et al. identified ten literature-based aspects of simulation that lead to effective learning. They pointed out the importance of feedback during the session, repetitive practice, integration of simulation with other learning strategies in the student's normal schedule, incorporation of a variety of procedural skill levels and patient conditions customized to the student's unique needs, provision of a controlled environment which closely approximates the real setting, and establishment of a defined outcome for each simulation.[135]

Adler et al. subsequently designed and implemented a simulation-based curriculum to provide EM residents a structured approach to the infrequently encountered seriously ill or injured pediatric patient.[5] Despite using a well-designed, rigorous intervention; they were unable to demonstrate the anticipated robust learning outcomes. The authors self-identified their failure to fully address real-time feedback and repetitive practice, the first two points on Issenberg's list. They subsequently added an eleventh point to Issenberg's original list recommending that educators dedicate sufficient resources, such as faculty and learner time, when developing plans for a simulation-based lesson.

Step 6 - Evaluation and feedback

As with any educational endeavor, evaluation of a simulation-based curriculum must assess both student performance and how well the tool meets the student's needs. In describing their model simulation curriculum for EM, McLaughlin et al. noted that they limited simulation-based assessment to formative evaluation.[127] Use of simulation for summative assessment requires development of reliable and valid assessment instruments. Issues surrounding the need for assessment instruments were thoroughly reviewed in the 2008 AEM Consensus Conference breakout session addressing the use of simulation in the assessment of emergency physicians.[136] A number of approaches have been used to create assessment tools of student performance. Many researchers have employed checklists[75,84,100,110,137-140] or a combination of a checklist and a global assessment.[137,141] Gordon et al. employed the high-stakes assessment tool developed for the EM oral board exam.[142] Researchers have demonstrated good inter-rater reliability[139,141] and some degree of face validity[140,141] for specific scenarios with a few tools, but a universal tool which fulfills all criteria is still lacking.

A number of investigators have developed tools to assess student satisfaction with simulation sessions.[29,34-43,59,60,61,143] The assessment components vary with the target student group and the simulation learning objectives. Potential assessment instruments for new programs can be derived through focus groups, open-ended comments from pilot study assessment or from the growing body of literature addressing simulation sessions with comparable groups.

Summary

Several converging trends have contributed to the growing popularity of simulation in EM training. The most significant is an emphasis on competency-based assessment. Concurrently, improved technology has led to large-scale production of simulation models which can recreate a wider variety of clinical scenarios incorporating one or more of the six ACGME core competencies. Finally, both of these changes have occurred in an environment characterized by trainee work-hour limitations and an increasing number of ED visits which have made it difficult to provide the degree of close observation needed to optimally assess trainees and provide comprehensive feedback.

Many current simulation models can be used to enhance development of the knowledge, skills, and attitudes needed to practice EM. Available simulators enable students to rehearse procedures or recreate life threatening emergencies characterized by physiologic extremes and the need for invasive interventions. Although enhanced technology has been a key factor promoting the growth of simulation in EM education, learning objectives and not technology should govern teaching tool selection. In many instances, a simulation model is the best tool for achieving EM learning objectives. In others, alternate teaching formats are more appropriate.

The future of simulation in EM training depends on outcome-based research which demonstrates a link between training and improved educational outcomes. Although recent work has provided some evidence of this link, more is needed. Dr. Gaba makes a strong case for the growing popularity of medical simulation in recent years by looking at high stakes environments, other than medicine, where outcomes are also dependent on individual and team skills. Industries such as aviation and nuclear power, he points out, have not waited for definitive proof of the effectiveness of simulation prior to incorporating it into their training programs.[144]

Available resources to support emergency medicine simulation training

Additional resources needed to start or sustain the simulation component of a training program are available on line. Some of the key resources available to provide information regarding cases, techniques, equipment, job descriptions, and meetings to support emergency medicine simulation training include:

1. Society for Academic Emergency Medicine – Simulation Academy
http://www.saem.org/saemdnn/Academies/SimulationAcademyHomepage/tabid/1302/Default.aspx (Accessed 4/24/10)
2. The Society for Academic Emergency Medicine – Simulation Academy Newsletter and Resources Page
http://www.saem.org/saemdnn/Academies/SimulationAcademyHomepage/SimNewsletterandExternalLinks/tabid/1308/Default.aspx (Accessed 4/24/10)
3. The Society for Simulation in Healthcare - Homepage
http://www.ssih.org/SSIH/SSIH/Home/ (Accessed 4/24/10)
4. The SAEM Simulation Case Library

http://www.emedu.org/simlibrary/ (Accessed 4/24/10)
5. The American Association of Medical Colleges MedEdPORTAL (Peer reviewed simulation cases)
http://services.aamc.org/30/mededportal/servlet/segment/mededportal/information/?q=simulation+&view=asSearch&submit=Search (Accessed 4/24/10)

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